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THE ELECTRICAL EQUIPMENT of 37 miles of standard gage railway has been ordered by the North Eastern Railway Co., of England. This line is in the neighborhood of Newcastle-on-Tyne, and the work is to be done under Chief Engineer Wilson Worsdell, Gateshead-on-Tyne, England. Bids for this work will be received until Oct. 7, 1902.

THE WATER POWER developed by the Chicago Drainage Canal is to be utilized by the Sanitary District for public purposes, and a dam is now being built at Joliet as a part of the project. The District, however, has delayed undertaking this for a considerable time, and a private company has endeavored to secure the right to utilize the power for its own purposes. The case has gone to the courts for a decision as to which party has the right to the water power.

GAS ENGINES USING BLAST FURNACE GAS are to be built to supply blast to four of the new furnaces which the Lackawanna Steel Co. is building at Stony Point, near Buffalo, N. Y. This will be the first example of this practice in the United States, although in Europe the system has been extensively adopted during the past three years.

SUPERHEATED STEAM is used in a 4,500-HP. vertical cross-compound engine just installed in the Lincoln power station of the Boston Elevated Ry. The engine was designed and built by the Westinghouse Machine Co., and installed by Westinghouse, Church, Kerr & Co. The high-pressure cylinder is fitted with poppet valves. The superheaters were built by the Babcock & Wilcox Co.

A 35-LEVER WESTINGHOUSE ELECTRO-PNEUmatic machine in use at the Sullivan Square terminal of the Boston Elevated Ry. controls the movements of about 500 elevated trains and 600 surface cars daily, requiring about 6,000 separate movements of switches and signals. The machine is operated by two men.

THE BARMEN-ELBERFELD SUSPENDED RAILWAY has been reported on by Professor Goering and Messrs. Köpcke and von Borries, who had previously reviewed the designs for the railway. (Eng. News, Jan.-June, 1900, p. 218.) The report, among other things, remarks upon the smooth riding of the cars and the absence of jerk in starting and stopping. Pendulum vibrations of the cars occur at times during the operation, but they are of much less consequence than the lateral vibrations and shocks on ordinary railways. The usual speed on the line is 18 to 23 miles per hour, but on the occasion of the inspection by the committee the speed was raised to 25 or 30 miles per hour, maintained even on curves of 300 ft. radius. A glass filled with water to within one-half inch of the top and standing on the floor of the car during the trip did not spill a single drop of water. On the line in question the construction limits the lateral tilt of the cars to 15° from the vertical, which corresponds, on a curve of 300 ft. radius, to a speed of 34 miles per hour. The report suggests that on such lines a tilting of 35° to 40° might be considered a permissible maximum, which would correspond to a speed of 56 to 61 miles per hour on a curve of 300 ft. radius, or a speed of 125 miles on a curve of 1,450 to 1,240 ft. radius. The committee considers the suspended type of railway, as exemplified in the Elberfeld-Barmen line, eminently adapted for high-speed traffic.

A RUSSIAN RAILWAY CONCESSION is said to have been granted to an English and Russian syndicate to build 1,350 miles of railway intended to connect the Trans-Siberian line at Tomsk with the Central Asian Railway at Tashkend. The Russian Government is to guarantee 65% of the share capital. The purpose of the road is to enable the copious corn product of the Barnaul and Busk region to be marketed in Eastern Siberia and thus keep it away from Western Europe, where it enters into injurious competition with the crops of that section.

THE CAPE-TO-CAIRO RAILWAY would be 5,700 miles long in a direct line between Cape Town and Cairo. At the present time the rails are laid to within 200 miles of the Zambesi, or about 1,500 miles from Cape Town; and there is now a railway from Cairo to the junction of the Blue and White Nile, or 1,400 miles from Cairo. It is thus seen that a line 2,800 miles long must yet be built to connect these terminal systems. The Uganda Railway is built, connecting the port of Mombasa, on the Pacific Ocean, with Port Florence, on Lake Nyanza; the length of the line is 500 miles. The Bulawayo-Beira Railway connects the system with the ocean at the last-named port. At Bulawayo the line is 4,469 ft. above sea level.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a butting collision on the Chicago, Milwaukee & St. Paul Ry., near Rhodes, Ia., on Aug. 6. A construction train was going out after dinner and on a curve met a fast freight train going in the opposite direction. Two men of the train crews and eleven workmen were killed outright, and about a score of others were injured.

A RAILWAY GRADE OF 60 IN 100 is being laid down on a railway in the Tyrolese Alps, near the village of Kaltern, says the London "Chronicle." The road ascends the Col du Mendel, 2,550 ft. high, and the grade mentioned is the maximum. The details of the line and motive power are not given.

THE CONCRETE AND GRANITE DRY DOCK NO. 3 at the U. S. Navy Yard at Norfolk, Va., will be let on Sept. 13, 1902, sealed proposals being invited up to that time. This dock and the equipment is to cost $1,200,000. The plans of the Bureau of Yards and Docks call for the following general dimensions: Length at coping level on center line out to out, 643 ft.; length on floor, head to abutment, 528 ft.; least width of entrance at coping, 112 ft. 5 ins.; width at coping in body of dock, 144 ft.; width at floor, 90 ft.; depth from coping to mean high water, 5 ft.; depth from coping to floor, 39 ft. 6 ins.; depth over sill at mean high water, 32 ft. The dock is to be founded on piles, and will be built of concrete with a granite facing, and with a continuous waterproof course of felt laid in asphalt, as shown on the plans.

THE EXPENDITURES OF THE CROTON AQUEDUCT Commission to June 30, 1902, have amounted to $45,726,765. Most of this has been on account of the new aqueduct, new Croton dam, and the Jerome Park Reservoir.

THE STEAMSHIP "KAISER WILHELM II." for the North German Lloyd Co., was to be launched from the Vulcan shipyard, at Stettin, on Aug. 12. This ship is 707 ft. long, 71½ ft. beam; has a draft of 20 ft. and a displacement of 19,500 tons. She is to be equipped with engines of 39,000 HP., and will carry 1,000 cabin passengers, says a Berlin news item.

DRIVING LARGE RIVETS.—The rivets through the keel of the seven-masted schooner "Thomas W. Lawson," which was launched from the Fore River shipyards a short time ago, were nearly 5 ins. in length by 1¼ ins. in diameter. It was not possible to upset these properly with an ordinary yoke, one arm of which served as the anvil to resist the blows of the pneumatic hammer carried by the other arm. To have made the anvil heavy enough to accomplish the purpose would have produced a tool extremely awkward and difficult to handle in the cramped quarters underneath the keel. The difficulty was overcome by doing away entirely with the anvil and substituting a second pneumatic hammer. The two hammers, one on the end of each arm of the yoke, worked perfectly and there was no further trouble in making the rivets fill the holes completely. The strokes of the hammers were so exceedingly rapid that it made no difference whether they worked synchronously or not.—Iron Age.

A LOAD OF 8,440 NET TONS OF IRON ORE is the record made by the schooner "John Smeaton," sailing from Duluth, Minn., on Aug. 5. The previous greatest steamer record was 7,417 gross tons. Boats are now loading to 18 ft. 6 ins. draft on the Lakes.

THE CRAMP SHIPYARD IN PHILADELPHIA, says a history of the enterprise just issued by The William Cramp & Sons Ship & Engine Building Co., was founded in 1830 by William Cramp, who remained at the head of the company for 49 years. From a very small affair the main shipyard now covers 46 acres, with docks covering about 6½ acres, or 52.4 acres in all. The principal building is 1,200 ft. long, 72 ft. wide, with a ground and floor space of 460,000 sq. ft. It employs a maximum of 8,000 men. Counting vessels under construction, the Cramp shipyard has built 321 vessels and 220 engines. Of these vessels 25 have been U. S. steam warships, constructed at various dates since 1861, and including the "New Ironsides" of the Civil War and the new battleships "Iowa," "Alabama," "Maine," "Colorado" and "Pennsylvania," the three last not yet completed. One Japanese and six Russian warships have also been built at the same yards.

THE GARBAGE, ASHES AND REFUSE COLLECTION and disposal contract at Newark, N. J., was awarded by the Board of Street and Water Commissioners on Aug. 7 to Mr. Benj. Meyer, of Newark, the lowest bidder. The contract is for five years from Jan. 1, 1903, and the price increases by $2,000 a year from $79,000 for the first year, making a total of $415,000 for the whole period. There will be three separate collections, comprising (1) garbage, (2) ashes and rubbish, (3) paper. For the purposes of collection the city is to be divided into two districts. District No. 1 will embrace about 1,220 acres, comprising the most populous part of the city. District No. 2 will include about 8,700 acres, surrounding No. 1. The distances to be covered will be about 7½ miles, north and south, and 4 miles east and west, including 228 miles of streets, of which 124 are paved and 104 miles are unpaved. Collections are to be made, unless otherwise directed, between 7 a. m. and 6 p. m., Sundays excluded. Between May 1 and Nov. 1 garbage will be collected once a day in District No. 1 and four times a week in No. 2; while ashes and rubbish will be collected three times a week, on alternate days, in District No. 1, and twice a week in No. 2. Between Nov. 1 and May 1, garbage will be collected three times a week in District No. 1 and twice a week in No. 2, and ashes and rubbish will be collected daily in No. 1 and four times a week in No. 2. Waste paper, in both districts, is to be collected once a week. The final disposition of all garbage is to be by either cremation or reduction, at the option of the contractor, and all garbage must be under final disposal by 6 a. m. of the day following its receipt at the disposal works. Ashes and rubbish (or all material collected except garbage and paper) may be deposited within the city at some place or places designated by the contractor and approved by Board of Street and Water Commissioners, or by the General Superintendent of Works. The contractor is to be under a surety company bond for $25,000, during the period of the contract, to ensure the faithful performance of the contract. It is generally understood that the contractor will erect a combined reduction and cremation plant, the latter for readily combustible waste only, the heat generated to be utilized in operating the reduction works. Mr. Ernest Adam is Engineer of the Street and Water Department of Newark.

THE SCHOLER SUCTION DREDGE "NICOLAUS," described by its inventor at the Ninth International Navigation Congress, is claimed to be a great improvement on the ordinary suction dredge. By using a head of peculiar construction on the suction pipe, the volume of water lifted with the dredged material can be regulated and limited to the minimum quantity required. This head is a closed receiver, into which the material is pushed, and into which the necessary amount of water can be admitted. The material and water are mechanically mixed in this receiver and then lifted by the pumps into hoppers of 400 cu. m. capacity. In working in compact soil, water under pressure can be admitted to the head to assist the excavator. The "Nicolaus" is working on the Kaiser Wilhelm Canal.

OIL-FUEL IS BEING USED on some of the Willamette and Columbia River steamers as a substitute for wood. Oil can be had for $1 per barrel, and a barrel of oil is claimed to be equal to a half-cord of wood, the latter costing from $2.25 to $2.75 per cord. The cost of installing oil-burners is about $500 per boat of considerable size. The larger boats use coal for fuel; but as coal is also expensive they may change to oil, should the experiments now being made prove economical.

A THAMES RIVER TUNNEL for pedestrians will be opened to traffic this month. It was built for the London County Council by J. Cockrane & Sons for $600,000. The tunnel is 11 ft. diameter, 1,217 ft. long and its axis is 60 ft. below high water level. The entrance at each end is by shafts, 35 ft. diameter, fitted with circular stairways and electric elevators. The top of the tunnel is 13 ft. below the river bed, and the work was done with a shield and compressed air. The tunnel connects Greenwich at Church St. with Millwall, near the Island Gardens.

THE ASSUAN DAM AND RESERVOIR ON THE RIVER NILE.

By Clarence T. Johnston.*

The total cultivated area of Egypt to-day is about 5,000,000 acres. Each year a considerable area does not receive sufficient water for the growth of crops, and over 1,000,000 acres could be brought under cultivation in lower Egypt if the water supply were adequate. Before much agricultural development can take place, therefore, some change must be brought about in the irrigation system by which a supplemental volume of water will be added to the low discharge of the Nile. There is an abundance of water each year from the middle of July to the middle of the following April, and a large part of the discharge of the Nile goes to the Mediterranean without being used. However, from the first of July until the first of December the water carries so much silt in suspension that it is almost out of the question to consider storage until during the winter months.

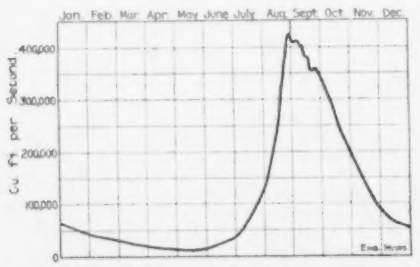

Fig. 1. Mean Discharge of the Nile at Assuan.

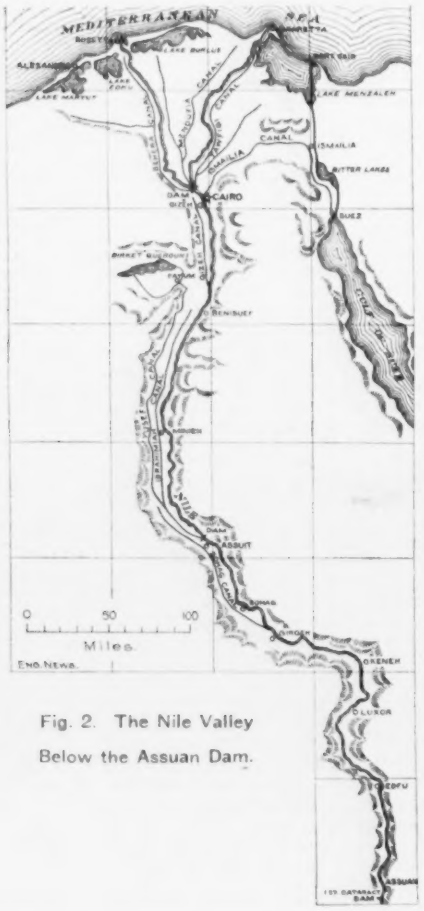

Fig. 2. The Nile Valley Below the Assuan Dam.

The accompanying diagram, Fig. 1, shows how the Nile fluctuates in discharge throughout the year. While some years are more favorable than others, the variations in flow take place at about the same time each season. No stream in the United States resembles the Nile in this respect.

The Nile furnishes about 93,000,000 acre-feet of water during an average year. It will only require about 27,000,000 acre-feet of water to supply all the land which is now under irrigation or which can in the future be cultivated. This leaves 66,000,000 acre-feet of water which will still be unused after all of the land in Egypt is being farmed.

Reservoir construction has been discussed for many years. Many sites have been surveyed and examined by engineers and technical commissions, and the big dam at Assuan, 700 miles from the Mediterranean (see Fig. 2) was finally decided upon. Its selection would indicate that unusual advantages for dam construction exist at the first cataract, just above which the line runs. Archeologists and persons of sentimental rather than practical ideas had for a long time hoped to see Lake Moeris restored. This body of water probably covered a portion of what is now known as the Fayum province, and served as a regulator of the Nile for some time following the period of the XIIth dynasty. A number of other sites were examined, but the granite formation just above the first cataract finally secured the majority vote, and the great dam, whose construction was begun in 1898, was completed during July of the present year.*

After the selection of this site, the engineers have had one difficulty after another to overcome. The dam as originally planned by Mr. Willcocks (see Fig. 3) was to run from one island to another where the material for the foundation was the best. The dam was to be slightly over 100 ft. high, and to be supplied with sluiceways and gates which would discharge the entire high-water flow of the Nile and enable water to be stored at any time desired. At this time the archeologists filed objections, holding that if the reservoir were constructed with a depth of water of 100 ft. at the dam, the island Philae, two miles above, would be completely submerged. This island contains a number of interesting temples, but none of great antiquity, most of them having been constructed during the Ptolemaic period. A compromise was finally reached. The height of the dam was reduced to store 66 ft. of water instead of 100. The island will be submerged during the time when the reservoir is full, but tourists can still see the temples and can visit them by boat. As Mr. Willcocks says, the reservoir has been spoiled and the temples have not been saved.

The length of the dam is about 6,000 ft. The entire structure rests upon a solid granite foundation. In some of the many channels of the river it was necessary to go 60 ft. below the river bed before solid material was found. The dam is therefore over 120 ft. in height at these places. Outside of this feature, construction presented no special difficulties. The neighboring hills furnished a fine quality of granite in almost unlimited quantities. Light railways were built to the quarries, and the dimension and rubble masonry stone was brought alongside the dam in this way. The Egyptian Railway connects directly with steamers at Alexandria, and cement was delivered at Challal, within two miles of the dam site. It was transferred from the Egyptian Railway to the local construction road and carried direct to the points where used. The heavy dimension stone of which the face of the dam is constructed, was lifted by derricks from the cars to the place where the stone was to be put in the dam. The rubble masonry stone and mortar were carried up inclined planes by native workmen, who received about 15 cts. a day for their labor. The masons were nearly all Italians. The dimension stone was cut at the quarry and all corners were protected by wooden frames until ready to lay in place in the dam. The dam contains about 1,000,000 cu. yds. of masonry.

The work on foundations and lower parts of the dam had to be carried on during low water. The numerous channels into which the Nile is divided favored this work, as temporary dams thrown across the channel in which the work was being carried on threw the water into others, enabling the masonry work to be prosecuted with great ease. During each June the dam had to be put in shape for the coming high water, and the entire year's work had to be planned so as to permit the water to run over the structure without doing it injury.

The cross-section, Fig. 4, of the dam shown herewith needs but little explanation. The depth of the water at the dam will be 65.6 ft. when the reservoir is full. The roadway running along the top of that portion of the dam containing sluiceways is 16.4 ft. wide. A large part of the eastern end of the dam, containing no sluiceways, is narrower and the roadway is reduced to 9.8 ft. The

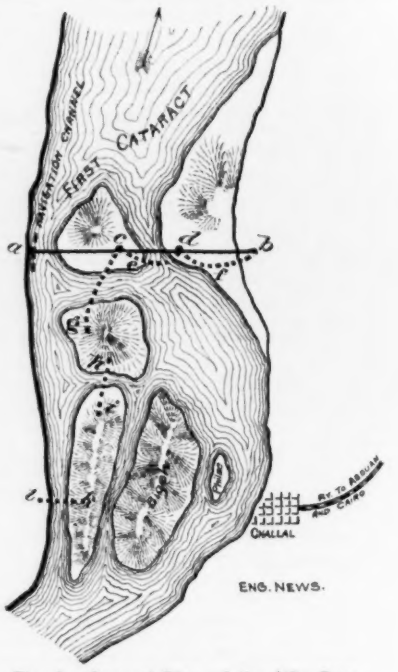

Fig. 3. General Plan of the Nile Dam.
(The line a b shows the location of the dam as built, while the broken lines l k, i h, g c e d f b shows the location recommended by Mr. Willcocks.)

rubble masonry of the body of the dam is laid in 4 : 1 cement mortar and the down-stream slope is faced with squared rubble laid in the same mortar and pointed in 2 : 1 cement mortar. The up-stream slope, being submerged a large part of the year, is faced with squared rubble laid in 2 : 1 cement mortar and pointed with the same. The batter of the lower slope of the dam is 1½ on 1. Buttresses 3¾ ft. thick and 26 ft. wide are located between each set of ten sluiceways, or about 240 ft. apart. The buttresses are added to the dam more for the sake of appearance than because they are needed to increase the strength of the

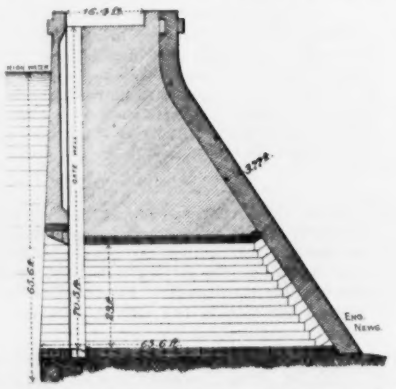

Fig. 4. Cross-Section of Assuan Dam at a Lower Sluiceway.

wall. These buttresses may be seen in the general view, Fig. 5, which shows the eastern end of the dam finished. Fig. 6 shows the pylon of the Temple of Isis, on the Island of Philae. When the reservoir is full the ground here will be covered to a depth of several feet. The Egyptian government therefore undertook the strengthening of the foundations of the structures on the island. A pile of earth excavated from the base of the colonnade at the right is shown in the view.

There are 180 sluices, of which 140 are on a low level and 40 are on a high level, to be

*Assistant Chief, Irrigation Investigations, U. S. Department of Agriculture, Cheyenne, Wyo. Mr. Johnston visited the Assuan Dam in January, 1902.—Ed.

*Cablegrams state that the last coping stone was laid on July 30.—Ed.

operated when the reservoir is full or nearly so. The area of the lower sluices is 150 sq. ft. each. The upper sluices have only half as great an area. Fifty of the lower sluices are supplied with ordinary regulating gates furnished with rollers. The remaining 90 gates are of an improved design, recommended by Mr. Willcocks. A number of the lower sluices have cast-iron linings. These were adopted not so much because they were cheaper

FIG. 5. VIEW OF ASSUAN DAM LOOKING EASTERLY FROM BELOW.

or because they would differ in permanency from the masonry sluiceways, but because they could be completed during the period between two seasons of high water. The gates are raised by stationary winches, and as a precaution there is a traveling winch which can be propelled to any point along the dam. In addition to this, the dam is supplied with emergency gates, which roll down from above, covering the opening in the sluiceway. A navigation channel, Fig. 7, has been constructed along the western margin of the river, which will permit small boats to ascend the cataract.

It is proposed to close the lower gates about the first of December each year and store water until some time in May. When water is first drawn off it will pass through the high-level sluiceways, the lower gates not being operated until the head has been greatly reduced.

The Assuan reservoir will store practically all of the flood water of the Nile after the first of December and before the high water of the following year. The water of the Nile during August, September, October and November carries large volumes of silt. On this account the engineers of the dam are afraid to close the gates of the reservoir before Dec. 1. How the storage system is to be extended with profit has not yet been determined.

It is a matter of considerable surprise to engineers visiting Egypt that no accurate surveys have been made to determine the capacity of the Assuan reservoir. The capacity as given, 800,000 acre-feet, is largely an estimate. Such surveys as have been made of the reservoir and the few cross-sections of the valley which have been taken will not warrant even an approximate estimate of its storage capacity. Before all of the land in Egypt can be thoroughly reclaimed a reservoir system must be constructed which will store about 2,800,000 acre-feet. It will be seen, therefore, that this kind of work has just begun.

When completed, the dam will cost Egypt about $9,000,000, which is to be paid in 60 semi-annual instalments of $382,845 each. This will make the total cost of the dam, including interest, $22,970,000. In addition to this burden, Egypt has raised $5,746,600 for improving the canal systems, especially those of upper Egypt, so that the water supplied by the reservoir may be fully utilized. A large dam has been constructed at Assiut, which will raise the water in the Nile so that two of the large canals diverting water at that place will be supplied during low Nile. It is expected that the reservoir water will be of sufficient benefit to Egypt so that the yearly payments can be met by the additional returns to the government through taxation.

The engineers in the employ of the Egyptian government are now examining reservoir sites farther up the Nile, and it will only be a question of a few years before the construction of additional storage works will be undertaken. Besides furnishing the farmer with water throughout the year thus enabling him to grow several crops during that time, the administrative officers have many problems to solve. The physical difficulties connected with the maintenance of the Nile banks and of the canals require unceasing expenditure and labor. But little has been done to bring about a just division of water among the irrigators. The measurements of the discharge of the canals are very roughly made, and each irrigator is limited in the amount he diverts only by the capacity of his water lifting device.

Because Great Britain has occupied Egypt for the past 20 years, it has been commonly assumed that she has furnished the funds for the internal improvements of the country. Such is not the case. Whatever is done for the benefit of the native Egyptian comes from his own pocket. Egypt is paying English officers and engineers and supporting an English army of 3,000 men. In return, Great Britain has established a stable government and has restored the credit of Egypt. Outside of the positions occupied by the English in Egyptian service, Egypt has a most complicated government, and with the interest on the national debt, the yearly tribute to Turkey and the expense of keeping up the courts and commissions for the protection of foreign subjects and foreign interests, the Egyptian farmer has a heavy burden of taxation. This amounts to about $5 a year for each acre of land he owns. The debt of Egypt is over $500,000,000, or about $100 to each acre of land under cultivation. The tax gatherer watches the peasant closely, and should he have a temporary period of prosperity the government shares in it.

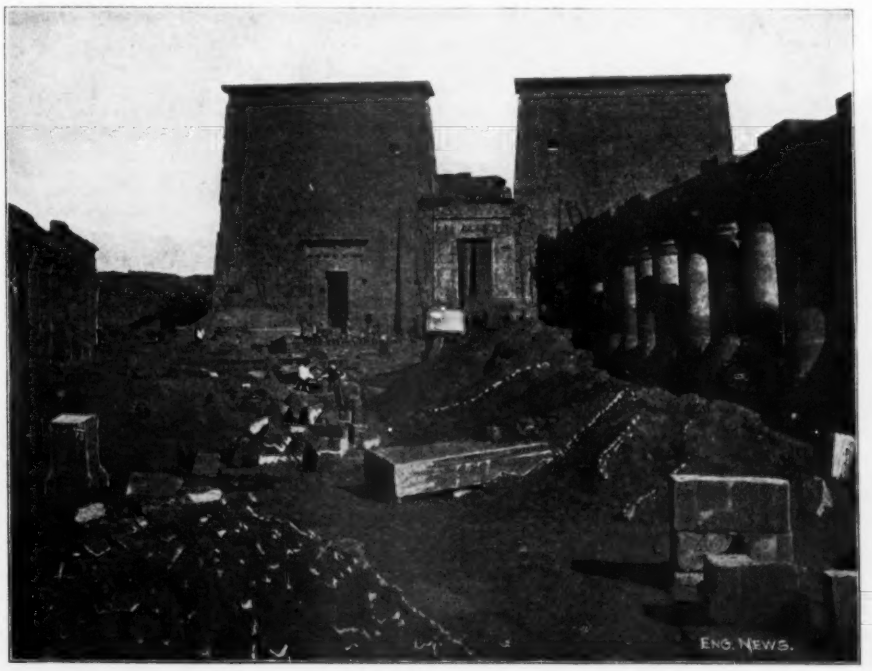

FIG. 6. PYLON OF TEMPLE OF ISIS, ON THE ISLAND OF PHILAE.

MODERN DEVELOPMENTS IN THE PRODUCTION OF OPEN-HEARTH STEEL.*

By James Christie,† M. Am. Soc. M. E.

All malleable forms of iron and steel as now produced in commercial processes are made from the products of the blast furnace; that is, they are all produced from cast iron. Former methods of producing malleable metal direct from the ore, which lingered until recent date from the earliest recorded times, are now practically extinct. There are three existing commercial methods for refining cast iron and producing the malleable product—viz., the puddling or boiling process, the Bessemer process, and the open-hearth process. By these three processes, in a commercial sense, all the malleable forms of iron are now made, and of the entire products of the blast furnaces, now aggregating about one and a half million tons per month in this country, about one-half passes through the Bessemer converter. Over one-fourth of the total product passes through open-hearth furnaces, and three-fourths of the whole open-hearth product is made in basic-lined furnaces, the other fourth being produced from acid-lined furnaces, the latter being the original form of the open-hearth furnace as at first perfected.

During the reduction of iron ores in the blast furnace the metal is associated with numerous metalloids, which are generally derived from the original ores. The most important of these, or those that are frequently dealt with in ordinary chemical analyses, are carbon, silicon, manganese, phosphorus, and sulphur. The pig metals desirable in ordinary basic open-hearth practice will average in chemical composition about as in the first column of figures in the following table:

	Per cent	
Carbon	3.5 to 4	0.1 to 0.3
Silicon	0.5 to 1	.....
Manganese	0.0 to 0.5	0.4 to 0.6
Phosphorus	0.5 to 1	0.04 to 0.08
Sulphur	0.05 to 0.1	0.04 to 0.08

It is desired to eliminate the metalloids in the original pig, and for the production of steel having qualities suitable for ordinary structural purposes, the metalloids should be reduced to the percentages given in the second column above. Carbon, silicon, and manganese, having a high affinity for oxygen, at high temperatures are readily removed from the metal by the oxygen of the atmosphere. Phosphorus and sulphur, however, have a strong affinity for the iron, and they cannot be removed by atmospheric oxidation. Moreover, as they are acids in a chemical

*A paper read before the Engineers' Club of Philadelphia and published in its "Proceedings" for July.

†Chief Engineer Pencoyd Iron Works, Pencoyd, Pa.

sense—that is, they form acid compounds when oxidized—it is necessary to expose them, when at a high temperature, to the action of lime, or other powerful mineral bases that have such an active affinity for them as to pull them away from their association with the iron. Until a recent period the refractory linings of our furnaces were made of silicious materials which were also acids in a chemical sense, and it was impossible to use the powerful mineral bases in this form of furnace without fluxing and destroying the lining of the furnace. Consequently, in the original acid furnace it was necessary to use only such metals as were sufficiently low in phosphorus and sulphur to yield a satisfactory finished product.

The large majority of our iron ores contain considerable proportions of these objectionable elements. As the necessity of working these ores became pressing, it resulted in the development of the basic furnace—that is, a furnace whose refractory linings were mineral bases—and these are usually either magnesite or dolomite, the latter a compound of lime and magnesia. The use of these basic linings permits of the addition of large quantities of lime tenaciously to the metal, and, as their presence above very minute percentages is very objectionable, their elimination is one of the most difficult problems the metallurgist has to deal with.

COMPARISON OF THE PUDDLING AND OPEN-HEARTH PROCESSES.

It will be observed that the low-carbon steel now used so extensively for structural purposes has a very high melting temperature, and the manufacture of this metal has been rendered practicable by the development of furnaces in which the necessary high temperatures can be produced and maintained. In fact, this is the essential distinction between the puddling process and its successor, the open-hearth furnace and process. In the former, as the metalloids are removed by oxidation, the separated metallic iron is never at a high enough temperature to be in the molten condition. It is simply a pasty mass of open iron sponge which is welded together. Therefore the refining of iron as performed in the puddling furnace is a process of welding or agglutination, and the metal is handled in the solid condition, whereas in the open-hearth

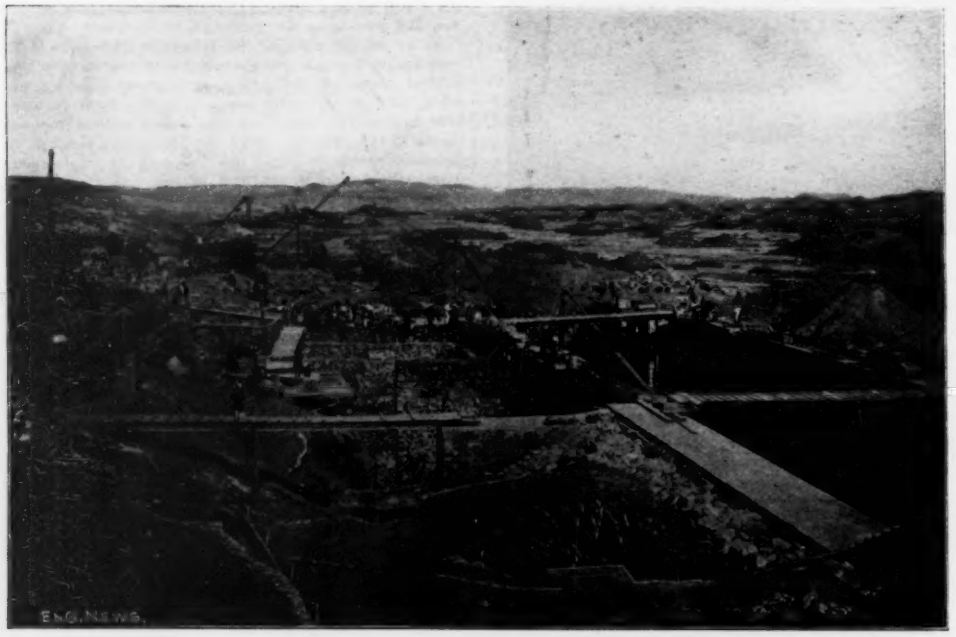

FIG. 7. LOOKING NORTHERLY FROM LINE OF ASSUAN DAM, SHOWING FOUR LOCKS IN NAVIGATION CHANNEL UNDER CONSTRUCTION.

to the molten metal, and also permits of much larger additions of oxides of iron, such as ore, mill scale, etc., than could be tolerated in the acid-lined furnace. By the use of these reagents the excess of phosphorus and to some extent that of the sulphur can be reduced and permits the utilization of large quantities of ores that could not otherwise be handled, with a resulting product of unquestionable excellence if the process is properly carried out.

The higher the percentage of the metalloids, especially carbon and silicon, associated with cast iron, the lower the melting point will be, and the lower the specific gravity of the metal; and also, in a general sense, the metal is softer and has a lower tensile strength. As we eliminate the metalloids the temperature of the melting point is elevated and the specific gravity is increased, until we approach the condition of pure metallic iron, when the melting point and specific gravity will be maximum. When all the silicon and a little over half the carbon usually present in the pig iron are removed, the metal approaches the condition of high-carbon steel, when the tensile strength is maximum. As the carbon is still further removed, the tensile strength lowers, but the ductility of the metal is increased. A large proportion of steel used for structural purposes at the present time is basic process open-hearth steel, having a tensile strength averaging about 60,000 lbs. per sq. in. of section and containing from 0.1 to 0.3% of carbon.

Briefly, then, the action of refining cast iron consists in reducing the carbon content to the desired point, which is done either by removing almost entirely the whole original content and adding sufficient to bring it to the requisite standard, or else maintaining the desired proportion of the original carbon. The silicon is all oxidized and sometimes a small percentage restored for specific purposes. The manganese is readily removed by the oxygen of the atmosphere, and a considerable proportion, usually from 0.4 to 0.6%, has to be restored, as the presence of manganese is necessary as a general corrective, and steel of a satisfactory quality is not made either by the Bessemer or by the open-hearth process without the addition of manganese. Phosphorus and sulphur are removed as far as possible. These constituents cling very

furnace it is a fusion process and the metal is produced from the furnace in a molten condition.

We might very briefly review the development of the puddling furnace, as there is a very close analogy between this and modern developments in the open-hearth furnace. About a century ago, when the puddling furnace was in its primitive form, the metal was treated in a furnace hearth, whose sides and bottom were of silicious materials, in many respects comparable in a humble way to the acid open-hearth furnace. With this original type of puddling furnace no metals except those of the highest grade—that is, free from objectionable metalloids—could be handled, nor could any reagents of a basic character be used in the furnace. Early in the last century the puddling furnace developed to a higher stage. The bottom was formed of iron plates, protected by a coating of oxide of iron cinder, and the walls of the hearth were protected with non-silicious materials. This was a distinct advance in the art, and the process was usually associated with a preliminary refinery treatment, which removed a large part of the carbon and silicon and facilitated the final treatment in the puddling furnace. It was not the custom to use large quantities of oxides of iron, and the slag produced being small in quantity, it was subsequently customary to denote this process by the term of dry puddling. Toward the middle of the century a further development took place. The walls or jambs of the furnace were built of high-grade iron ore and large quantities of iron ore and mill scale or other suitable oxides of iron were added to the charge, resulting, when the proper temperature was reached, in a very active reaction or boil, with the separation and discharge of considerable quantities of slag. It was customary, therefore, to term this process "boiling," and the workmen in some places were called "boilers," in contradistinction to the old form of dry puddling.

The essential distinction was that in the former process more reliance was placed upon the atmosphere as an oxidizing agent, and in the latter the oxides of iron, added to the charge, formed the oxidizing agents, with distinct economical advantages in reduction of labor, improvement in quality of product and in the yield of product, inasmuch as the waste of metal from atmospheric oxidation was fully compensated by the addition of a [illegible] iron recovered from the oxides. This final develop[illegible] of the puddling furnace was a basic process; in fact, it [illegible] quite common in certain districts to add considera[illegible] proportions of lime compounds to the charge, as a dephosphorizing agent. The further development of the puddling process as a mechanical operation was arrested by the rapid introduction and growth of the open-hearth furnace and the displacement of puddled iron by Bessemer and open-hearth steel.

THE BASIC PROCESS.

The introduction and development of the open-hearth furnaces were coincident with, or succeeded very closely, the Bessemer process. It has now had a commercial existence of a little over thirty years. For about half this period operations were confined entirely to the basic process—that is, a furnace whose linings were of a basic character. When it is remembered that there are but few deposits of ores that do not carry higher proportions of phosphorus, and frequently sulphur, than can be tolerated in the finished metal, and that the phosphorus content of the original ores will be largely found in the final product of acid process steel, it can be readily understood why strong incentives existed for a furnace lining that would permit the addition of basic material to the metallic charge. The desired lining material was found in magnesite and dolomite, and the former especially has taken precedence as the most suitable refractory for basic furnace linings.

As the basic-lined furnace was improved and developed and the necessary refractories produced in better shape for prolonged endurance, it became customary to increase the additions of lime and oxides of iron in the charge, just as obtained with the final development of the puddling furnace. This resulted in very active boils or reaction in the furnace, accompanied by the separation of large quantities of frothy slag, which greedily absorbed the carbon, silicon, and manganese in the original pig iron, and also, but more slowly, absorbed the phosphorus and a part of the sulphur.

It was soon found to be desirable to separate the impure slag thus created from the bath of metal—first, as a necessity on account of its bulk; second, to remove it as a covering from the metallic iron, leaving the latter more fully exposed to heat influences; third, to permit the addition of fresh basic charges as the original slag had become partly satisfied with the impurities that it had so greedily absorbed.

IMPROVEMENTS IN THE OPEN-HEARTH PROCESS.

Rolling and tilting furnaces are now extensively used and are favored under certain conditions, or for the purpose of facilitating special methods of working. The following advantages are claimed for the rolling furnace: A portion of the charge can be tapped if desired. The slag can be retained or prevented from entering the ladle. The excess of impure slag can readily be tapped off before the heat is finished. The hottest metal at the surface of the bath being drawn first, some maintain the mixture in the ladle is more uniform than when tapped from the fixed furnace. The objections to this form of furnace are the greater first cost and the somewhat greater expenditure for maintenance and repair.

The principal objection to the open-hearth furnace is that the process is a tedious one, and the efforts of the manufacturer have been devoted to expediting the process to obtain larger products in a given time and economize the production. Numerous experiments have been made by charging liquid metal either direct from the blast furnace or the cupola or metal partially purified in the Bessemer converter. Until a recent period none of these experiments have been entirely satisfactory. By using liquid cast iron with the ordinary process, the refining has not been facilitated so much as was anticipated, for it will be remembered that there is some refining action before fusion occurs when the metals are charged cold. Furthermore, there was erosion of the bottoms if liquid metal was poured into an empty furnace. This difficulty was augmented when partially blown Bessemer metal was used, inasmuch as it was both heavier and hotter than liquid cast iron. It was also found that the elimination of phosphorus in the open-hearth furnace was very slow and tedious when Bessemer metal was charged, as the phosphorus seems to cling more tenaciously at high than at low temperatures. Nevertheless, in the final development of the basic open-hearth furnace liquid cast iron is largely used, and the general features of the various methods practiced might be roughly described as follows:

The modern methods for expediting the process of refining, though varying much in the details, in a general sense consist in charging in the basic furnace large masses of molten iron with liberal additions of oxides of iron, such as ore, mill scale, etc., together with suitable additions of lime or dolomite. These additions form a highly basic slag, which rapidly absorbs the bulk of the metalloids in the cast iron. An active boil or reaction now occurs, and the large mass of slag thus created and partially saturated with impurities is then separated from the partly refined iron, and the latter, separated from the impure slag, is then boiled down and treated in the usual way to the required condition. The chief distinction in modern open-hearth practice, as compared to former methods, consists in the larger use of liquid metal and

...ger quantities of solid oxides used as reducing ...the use of the latter, of course, is only possible ...sic-lined furnace. The use of solid oxides in... the atmospheric oxygen not only prevents a ...iron that would otherwise occur, but in fact ...the product of iron delivered from the furnace ...nsfer of a portion of the metal in the ore to the ...harge. It is common practice now to draw ...furnace, in refined metal, full weight of the crude ...harged; in fact, frequently several per cent. in ...the charge is produced from the furnace. It will ...ved that there is a very close analogy between ...ation and that of the most highly developed stage ...uddling process. There are several specific pro... now frequently quoted, the most prominent being ...trand-Thiel process, the Talbot process, and the ... process.

BERTRAND-THIEL PROCESS.

...process originated at Kladno, Bohemia, in 1894-95. ...sic-lined open-hearth furnaces are used, one being ...ary or rough refining furnace and the second a ...g furnace. Into the primary furnace is charged ..., preferably molten blast-furnace metal, and ...times a small portion of scrap, if desired, together ... a liberal addition of ore, or other oxides of iron and ...one. Into the finishing furnace is charged scrap ...metimes additions of pig, with a small quantity of ...one and ore. In a general way, the most impure ...materials are charged into the primary furnace and the ...purest materials into the secondary furnace.

The primary furnace is heated for about three hours, when the highly basic slag absorbs most of the silicon and carbon, and the other metalloids are considerably reduced. The finishing furnace is charged later than the primary, and its contents brought to a pasty or molten condition. The primary furnace is then tapped and its metallic charge run into the finishing furnace, all of the slag of the primary being retained or skimmed off. When the two metals mix in the finishing furnace, a rapid reaction ensues for about a quarter of an hour, when the phosphorus content is then generally reduced to a satisfactory minimum. The heat is then finished by additions of ferro-manganese or spiegel and tapped in the usual way. The metallic charges, as in all processes of this kind, depend upon the relative values of pig and scrap. When scrap is dear, none is charged into the primary, or vice versâ; or the charge of the secondary may contain no pig.

The general theory of this process is to perform the rough work on the most impure materials in a separate furnace and to prevent the impure slag thus created from affecting the rapid finishing of the partly purified metals in the secondary furnace. Recent reports upon this process, operating with two furnaces of 15 tons capacity, show an average product of eight heats per day from the combined furnaces, or 48 heats per week, or an average product of about 720 tons per week. Blast-furnace metal of the following composition:

C.	Phos.	Sl.	Mn.
3.5	1.5	1	0.4

when run out of the primary furnace, is refined as follows:

C.	Phos.	Sl.	Mn.
2.4	0.10 to 0.20	trace	trace

The ore charged contains about 65% metallic iron and is approximately about one-fourth the weight of the metallic charge and limestone about 10% of the metallic charge: spiegel and ferro-manganese, about 2.5 to 3% of the metallic charge. Over one-half of the sulphur content of the metal is usually removed in the process. There is a large discharge of slag from the primary furnace which usually contains considerable phosphoric acid and is valuable as a fertilizer. It is claimed that by this process the fuel and limestone and refractories are somewhat reduced, as compared to the older method, and the output increased over the ordinary single furnace method about 70%. The process seems to be especially advantageous when very impure materials have to be treated.

TALBOT PROCESS.

A rolling furnace of large capacity is desirable. Furnaces of 70 to 100 tons capacity are now in use; one of 200 tons capacity is ready for operation, and even larger furnaces are considered. The initial charge having been boiled down to a finish in the usual way, a steel cast of one-fourth or more of the total charge is made, the slag being retained in the furnace. After pouring, a charge of solid oxides of iron, such as ore or mill scale, or heating furnace cinder, is added and melted; also, an addition of limestone, and through this highly basic slag the fresh charge of molten iron is poured. A very active ebullition or reaction follows for a period of 10 or 15 minutes, during which almost all the silicon and a portion of the other metalloids are oxidized or taken up by the slag from the molten iron. A large part of the slag thus created is drawn off. Fresh additions of oxide of iron and lime are charged and the whole charge worked down to finished steel in the usual way. Then a portion of this finished steel is cast as before and the process repeated continuously. From a furnace of 70 tons capacity, metal charges and steel casts of 20 to 30 tons are made, with a product of over thirty 20-ton heats, or about 650 tons per week. This is made from pig iron having the following average composition:

C.	Sl.	Sulph.	Phos.	Mn.
3.7	1	0.06	0.90	0.40

With the above amount of molten pig per week will be used about 80,000 lbs. iron ore, 10,000 lbs. manganese ore, 120,000 lbs. of cinder and scale, 100,000 lbs. of limestone, and 5,000 lbs. of ferro-manganese and silico-spiegel, the average results being 106% yield, or 6% more steel product than the weight of the pig metal charged. This process is best adapted for handling pig metal alone. Scrap can be passed through the cupola, if a cupola is used for melting, and, if desired, preheated scrap could be charged.

MONELL PROCESS.

By this process either pig and ore or pig and scrap can be used, as desired. Limestone and a large quantity of iron ore are charged on the hearth of a basic furnace, and the charge heated until it is pasty or nearly fused. On this heated material is poured the full charge of the furnace of molten iron. A rapid reaction occurs and the impure slag thus created is tapped off at a suitable cinder notch. In about an hour the bath is nearly free from silicon and manganese, and the carbon of the pig metal is reduced about one-half. About three-quarters of the slag thus created being removed, the heat is then boiled down to a finish with small additions of ore and lime in the usual way. Blast-furnace iron of the following composition is found, after the initial reaction takes place, to have the composition hereafter shown:

	C.	Phos.	Sl.	Mn.	Sulph.
Blast-furnace metal	4.00	0.065	0.70	0.85	0.06
After reaction.....	2.25	0.04	0.00	0.00	0.04

From a fixed furnace of 40 tons capacity, 17 heats per week are produced, or a period of eight or nine hours per heat is required, being a total of 690 tons per week. The average yield, or gain in steel over pig metal charged, is 102%. It is claimed to be desirable to work the metal at as low a temperature as it will slag properly to facilitate the removal of the phosphorus. When the temperature is high, the phosphorus clings to the metal and boils out slowly with the carbon, whereas at a lower temperature, phosphorus leaves before the carbon. In a 40-ton furnace the usual preliminary charge is 67,000 lbs. of limestone, with about 24,000 lbs. of hematite ore, or a portion of its equivalent of mill scale. These are heated for an hour and a half, until the ore is nearly fused. About 88,000 lbs. of liquid metal are then charged. The boil or reaction occurs at once and the impure slag is drawn off within an hour, and a small charge of ore and lime is then added and the metal finished in the usual way.

BOULDER-FACED MELAN ARCH BRIDGE, NATIONAL PARK, WASHINGTON, D. C.

By W. J. Douglas, C. E.*

The bridge illustrated in the accompanying cuts spans Rock Creek in the National Park, District of Columbia. It is a Melan concrete-steel arch, with an arch ring and spandrel wall facing of large boulders, as shown by Fig. 1. The adoption of the boulder facing was determined by the character of the stream and the natural surroundings of the site. Rock Creek is aptly named. Its bed consists of rock worn into irregular boulder-like forms by the rapidly flowing water, and the hills which rise precipitately from its edges show large areas of weather-worn ledges which in winter are bare of vegetation. Altogether the natural surroundings seemed to Capt. Lansing H. Beach, then Engineer Commissioner of the District of Columbia, and a member of the Board of Control in charge of the National Park, to suggest a boulder bridge as particularly suited to the site, and the sturcture illustrated was, therefore, designed under his direction during the summer of 1901. As designed the bridge is unique because of its large span for a boulder bridge and also because of the size of the boulders used.

The Rock Creek boulder bridge was built by Talty & Allen, of Washington, D. C., at a contract cost of $14,890. This cost was, however, increased to $17,500 by the steel girders which were furnished by the District, and by the cost of inspection and of royalties for the use of the Melan construction. Work was begun in October, 1901, and finished in June, 1902. The amount of money available for the work was $17,500, which necessitated the use of a concrete-steel arch, with a cement soffet, and a facing only of boulders. The boulders contain from 5 cu. ft. to 5 cu. yds. each. The facing was built according to the following specifications:

FACING.—The entire facing of the bridge shall be of boulder stones of the general size and shape indicated on the plans. The term boulder stones here is meant to cover loose rock which shall be hard, sound, durable and of a quality to be approved by the Engineer, whose edges have become weathered or water-worn, or both, and are more or less rounded. It is the intention to obtain a decidedly rustic effect on the facing, and to that end extreme care must be taken in the selection of the stones, and only mechanics who show an aptitude for this class of work shall be employed. No tool marks or fresh fractures will be allowed on the showing faces.

The boulder face of such stone shall project at least 2 ins. beyond the neat lines of the bridge, and this projection shall not exceed 15 ins., nor shall it be greater than one-half the least horizontal dimension of the stone. All joints shall be scraped and brushed clear of mortar to the depth indicated by the Engineer. The mortar shall consist of 1 part Portland cement and 2 parts sand. The backs of all boulders shall be plastered with a layer of mortar as specified, at least ¼-in. thick, immediately before ramming the concrete against them.

ARCH STONES.—The arch stones shall have a depth of between 3 and 4 ft., a width of not less than 18 ins. nor more than 36 ins., their length shall alternately be 18 ins. and 24 ins.; all dimensions to be measured exclusive of the projections beyond the neat lines. The joints shall be dressed so as not to exceed 1½ ins. at any point for at least two-thirds their depth and two-thirds their length, and as much more as the stones will admit. Each arch stone shall be cramped to the adjacent steel girder by means of a wrought iron cramp made from ¾ × ⅜-in. bar, the cramps to reach at least 2 ins. into each boulder, to be well cemented into them and securely cramped to the top of the girder. The outside girders shall be cramped to the adjacent girders by ten wrought iron cramps made

FIG. 1. BOULDER-FACED CONCRETE-STEEL ARCH BRIDGE OVER ROCK CREEK, NATIONAL PARK, WASHINGTON, D. C.
W. J. Douglas, Engineer of Bridges, Washington, D. C.
Talty & Allen, Washington, D. C., Contractors.

*Engineer of Bridges, District of Columbia, Washington, D. C.

from ⅝ × ⅜-in. bar (in construction we used ¾ × ¼-in. as it bent cold without fracture).

ABUTMENTS, SPANDRELS AND WING WALLS.—No dressing will be required on the stones used on this part of the work, but only well shaped boulders, laid on their broadest bed, will be allowed. Dressing will be permitted on such stones as cannot be properly bedded without it.

PARAPETS.—The parapet walls will be a continuation of the spandrel and wing walls. The boulder stone must reach entirely through the walls.

Instead of cramping the outside girders to the adjacent girders as specified, four ¾-in. wire cables were wrapped around the two outside girders and twisted by means of a toggle until all the slack had been taken up. This was done just before encasing the girders in concrete.

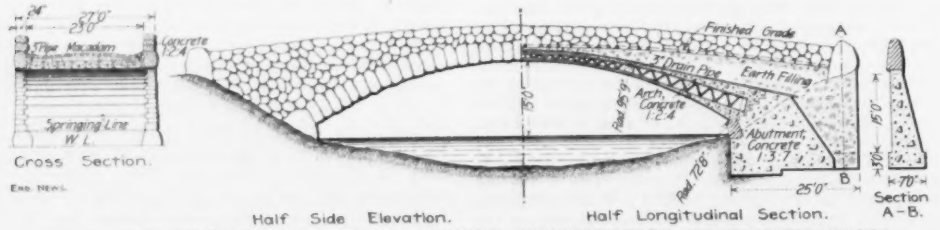

FIG. 2. ELEVATION AND SECTIONS SHOWING CONSTRUCTION OF BOULDER-FACED CONCRETE-STEEL BRIDGE.

The bridge was built with straight wing walls. It consists of one segmental arch with a span of 80 ft. and a rise of 15 ft. (Fig. 2). The wing walls are 25 ft. in length. The width of the bridge between face walls is 27 ft., and between parapets (inside) is 23 ft. The foundations were carried to solid rock at a depth averaging about 2 ft. less than shown on the plans. Two test pits—one on either side of the creek—were first sunk to determine the location of the rock and its overlying strata.

The centers were designed by the inspector, Mr. O. Stange, for the contractor. They were of a standard type for this class of work (Fig. 3). The posts were carried to solid rock and bedded upon concrete. Rock Creek is subject to heavy freshets during winter and spring time, at which time the arch was built, and it was thought wise to leave an exceptionally strong center with solid foundations.

In order to allow the boulder stones to project below the soffet from 6 to 18 ins., two 8 × 12-in. stringers, 3 ft. apart, were placed outside and on each side of the light stringers which carried the concrete arch. These stringers were fastened to the caps by means of iron warehouse hangers. The arch stones were blocked into position by means of wooden blocks which rested upon the stringers. The arch was struck 30 days after completion, it settled ⅝-in. and returned two days afterward to its original elevation. No cracks have developed.

The contractors used extreme care in the selection of the boulders with very effective results. There are no fresh fractures of any kind other than a few dog-holes, which are not very apparent. The cost of the facing boulders delivered at the bridge site, except the springing, arch and parapet stones, was about $12 per cu. yd. The arch stones cost about $18, and the parapet and springing stones cost about $22 per cu. yd. The haul varied between four and six miles. Considerable time and money was expended in hunting and uncovering field boulders, which after partial excavation would show cracks or impracticable shapes or other defects.

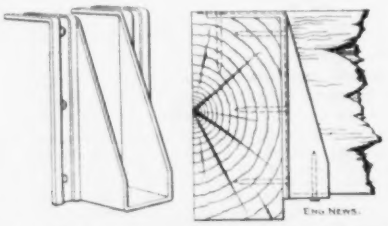

Fig. 3a. Steel Hanger or Stirrup Used in Centering.

In making the design, considerable thought was given to the practicability of getting suitable boulders for arch stones, which would bed without showing fresh fractures. The selection of proper stones was made by the Engineer before writing the specifications, so that feasibility of the construction was assured before soliciting bids. The contractors, however, obtained the boulders at an entirely different point and at a cheaper rate. No practical trouble was encountered in getting the arch stones, although it was thought that their selection would be extremely difficult. The contractor frequently selected boulders which when cut in two, would make two excellent arch stones, the fresh fracture being placed at the back and finally embedded in concrete. This was also true of the spandrel and wing wall stones.

The joints of the arch stones were all worked to a plane with bull points, and as a rule roughly pointed up by hand.

This work is somewhat better than specified. The four springing stones do not show to advantage. They contain about 5 cu. yds. each.

It was, of course, exceptionally difficult to get suitable springing and newel stones. The greatest difficulty, however, was experienced in getting the parapet stones, which required considerable dressing, as may be readily understood. A parapet constructed entirely of through stones was found practically impossible. A few such stones are scattered through the body of the wall, and the entire top, improperly called coping, consists of through stones, which thoroughly bond the parapet. Nearly all boulders throughout the work received more or less dressing. The cost of the boulder masonry was approximately as follows:

Face stones (spandrel and wing walls)....	$30 per cu. yd.
Arch stones	45 " "
Parapet stones	50 " "
Spring and newel	25 " "

Only two masons were employed on the work, and they were particularly careful and efficient. The small force employed on this work delayed the completion of the work, but the uniformity in the appearance of the facing paid for the delay.

In looking over the completed structure, I have to make a criticism, which is universally held by this office. The cement soffet, which on an average is 12 ins. higher than the bottom projection of the arch stone, can be viewed from one point on the roadway, where it turns, and it is apparent that the arch is not built of boulders throughout. These boulders, on account of their projection below the cement soffet, appear to stand out from the structure proper, which weakens its appearance. These points were considered in the design, but the smallness of the available funds demanded a concrete arch faced with boulders instead of a boulder arch throughout. In order to reduce the contrast between the cement soffet and the boulder ring stones, the soffet was colored a very dark gray, almost black, by the liberal use of lampblack. It is further the intention of this office to grow matrimony vine, Virginia creeper or preferably ivy over a portion of the face of the bridge and the soffet, so as to hide this line of demarcation. It is probable that the vines may be made to grow across the entire soffet, particularly near the springing line. However, if they are cut back 3 or 4 ft. from the face walls, the result would be entirely satisfactory.

The bridge was built under the direction of Col. John Biddle, Corps of Engineers, U. S. A., Engineer Commissioner, District of Columbia, and Capt. H. C. Newcomer, Corps of Engineers, U. S. A., assistant to the Engineer Commissioner. The criticism of the public at large of this bridge has been commendatory.

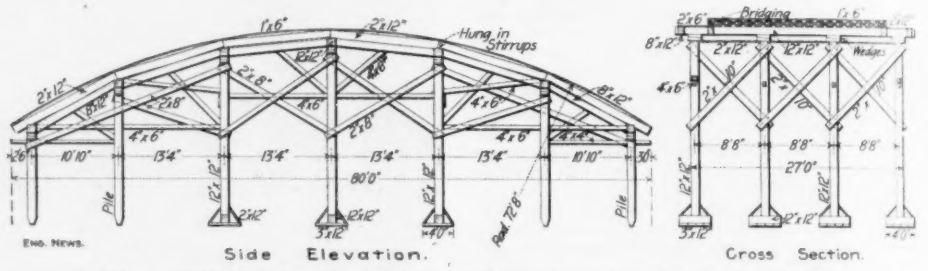

FIG. 3. TIMBER CENTER FOR BOULDER-FACED CONCRETE-STEEL BRIDGE.

BOOK REVIEWS.

AMERICAN INDUSTRIAL CONDITIONS AND COMPETITION.—Reports of the Commissioners Appointed by the British Iron Trade Association to Enquire into the Iron, Steel and Allied Industries of the United States. Edited by J. Stephen Jeans, Secretary to the British Iron Trade Association. London: Offices of the British Iron Trade Association, 165 Strand. Cloth; 6 × 10 ins.; pp. 590. Fully illustrated. $10.

A vast amount of information and misinformation, most of it presented in a popular and rather superficial fashion, has been published upon the subject to which this book relates. Accurate, expert studies upon it, however, have been few. The book before us is without doubt the most complete piece of work of this sort that has been attempted and it is, withal, a summary of present-day American practice in the production of iron and steel which can be found nowhere else.

The book is the outcome of a visit to the United States by an expert commission made up of Messrs. J. S. Jeans, Secretary of the British Iron Trade Association; Ebenezer Parkes, M. P., Axel Sahlin and Enoch James. The members of this commission were selected by the Board of the British Iron Trade Association and to each was assigned a specific field of inquiry. The commission arrived in New York on Oct. 1, 1901, and spent some months in its investigations. Each member of the commission submits a separate report in the volume before us, that of Mr. Jeans occupying the first 400 pages of the report, and the reports of the other three commissioners the remainder.

While the book is supposed to be written for the information of English manufacturers in the iron trade who are striving to meet American competition, it should be read, we believe, with equal or greater interest on this side of the water, and it certainly should find a place in every engineering reference library here. Nothing is more helpful to one than to have his acts reviewed and commented upon by a competent and impartial critic, and not a few American engineers and manufacturers will find information of practical value, we doubt not, in this volume.

It may be noted that the scope of the inquiry was a broad one and while largest space is devoted to engineering matters, the economic, industrial, moral and educational influences which bear on American success in production are given due attention.

LE SCAPHANDRE, SON EMPLOI. Par M. Dibos, Ingenieur-Conseil, Expert-Maritime, etc. Paris: Gauthier-Villars, Quai des Grands-Augustins, 55. Paper; 4½ × 7⅝ ins.; pp. 158; illustrated. 2.50 francs.

This is an exceedingly interesting, detailed and valuable treatise on diving apparatus; its design, use, connected appliances, etc. It is intended, in fact, as a manual for the diver. Historically, the writer ascribes the first invention of a diving apparatus to the Englishman, John Lettebridge, who, in 1721, used a barrel for this purpose, with two side openings for the arms. But, in 1769, Abbe de la Chapelle invented an impervious dress to be used under water and gave it the name of "scaphandre," or literally cork-corset, the name still applied to all diving apparatus in France. The metal head and body piece seems to have been introduced in 1797 by a German, Klingert by name, who improved upon the device of Lettebridge by making the barrel of metal, with a dome top, and added short leather sleeves for the arm and a tight belt at the waist; two glass bull's-eyes in front permitted the wearer to see what he was doing. But Klingert also added two pipes to supply fresh air and to remove the vitiated air. No improvement was made upon this primitive apparatus

until about 1830, when Dr. Mhurr, in France, and Mr. Siebe, in England, invented a diving dress that formed the basis of the modern apparatus.

The author divides his text under various heads covering the following subjects: The principles and theory of diving apparatus; the diver's equipment; air pumps, and the manner of using the apparatus, together with all necessary appliances; accidents from compressed air; various kinds of submarine work performed by the aid of divers; submarine lighting; and telephones; and, finally, advice to divers, remedies in case of accident, etc.

THE NEWBURYPORT CHAIN BRIDGE, built in 1828, stood until about two years ago. The original chain bridge, designed by James Finley, of Pennsylvania, was built at this point in 1810 by John Templeman, acting for Finley. In February, 1827, the first bridge broke down under a load of snow and a loaded wagon drawn by two yoke of oxen. When the bridge was rebuilt the next year heavier chains were used and more of them, and the bridge thus stood until about two years ago, when steel cables were stretched across on the old towers to sustain the weight of trolley cars. The "Boston Globe" reproduces the Newburyport chain bridge of 1828, but gives no dimensions.

THE SLOW SAND FILTERS OF THE WATER-WORKS OF HUDSON, N. Y.

By H. K. Bishop.*

The water-works system of Hudson, N. Y., is notable for including one of the earliest slow sand filtration plants in the country. Although the filters are now in very bad condition, the lower courses of the two beds not having been renewed or washed since their construction, in 1874-5 and 1888, respectively, and although the records are meager,† a brief account of the filter beds and their operation seems likely to be of interest.

The water-works were built with Mr. J. B. G. Rand as designer and chief engineer, directly after Mr. Rand had spent some time studying filtration on the continent of Europe. The population when the works were built, in 1874-5, was some 8,000 to 10,000, and in designing the filter bed Mr. Rand estimated that the daily consumption would not exceed 600,000 gallons for a number of years.

The water supply of Hudson is pumped from the Hudson River to the filters and an adjacent clear water reservoir, Fig. 1, on a hill. In the original plant two basins, shown in the view, Fig. 2, were built side by side, separated by an embankment 14 ft. in width at the top. The smaller, or north basin, is used for filtration as well as the storage of water. The basins are similar, merely differing in form and capacity; one, half full of filtering material, is the filter; the other the clear water basin.

The filter basin is 13.5 ft. in depth, has an area at the crest of the slope wall of 15,081 sq. ft., and at the surface of the sand of 9,081 ft.

The filtering material and drainage system is 6 ft. deep, and is made up as follows, beginning at the top:

6 ins.	fine white sand.
18 "	coarser dark sand.
6 "	¼-in. gravel.
6 "	½-in. gravel.
6 "	1-in. broken stone.
24 "	4 to 6-in. fragments of stone.

*Superintendent of Public Works, Hudson, N. Y.

†The water-works have been under the supervision of Mr. Bishop for less than two years.—Ed.

The fragments rest upon a concrete floor 6 ins. in thickness, having a slight inclination towards the middle or axial line, and this line towards the outlet. Along this line runs an openly laid 18 × 20-in. stone culvert, which is connected by a cast-iron pipe under the division embankment with a clear water well situated between the two basins. The filtered water passes over a gate or weir, where it is measured and its flow regulated by the raising or lowering of the gate operated from the top of the embankment. From the weir the water flows to the clear water basin, whence it passes into the effluent chamber through fine copper wire screens and thence to the 18-in. supply pipe.

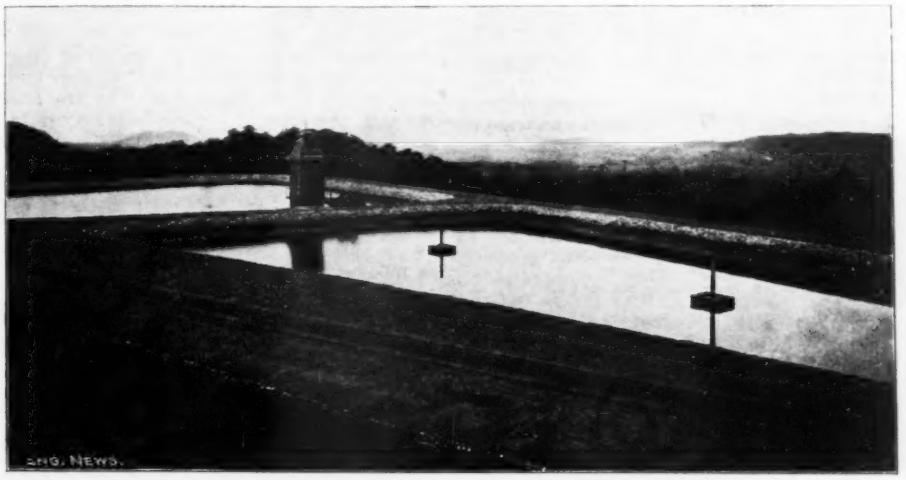

FIG. 2. VIEW OF EARLIEST FILTER BED AND CLEAR WATER BASIN, HUDSON, N. Y.

The clear water well is also connected by an 18-in. pipe directly with the 18-in. supply main, so that the city may be supplied from the bed without passing the water through the clear water basin.

The clear water storage reservoir has an area at its crest line of 32,696 ft., a depth of 20 ft. and a capacity of 3,200,000 gallons. Its slopes are 1 on 1½, and are faced with dry rubble masonry 12 ins. thick at the top and 18 ins. thick at the bottom, resting on 9 ins. of broken stone.

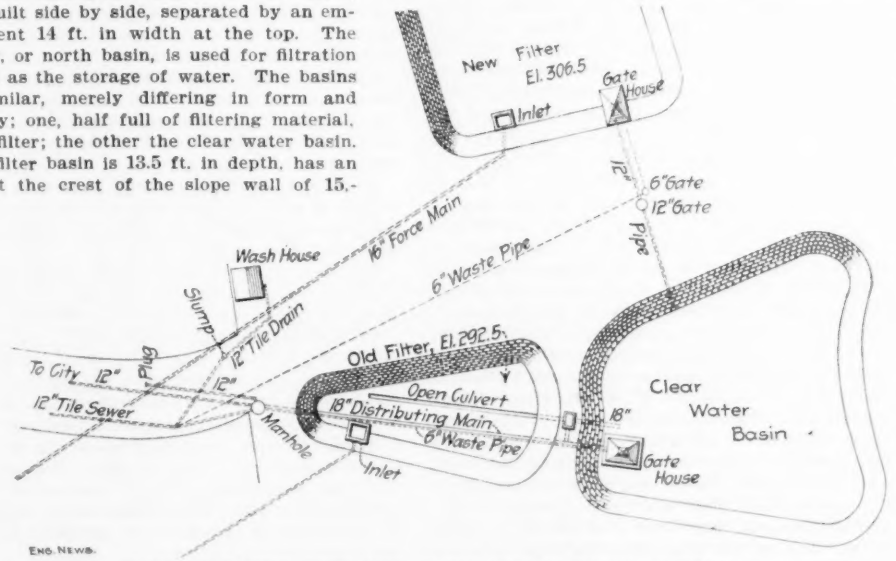

FIG. 1. PLAN OF FILTER BEDS AND CLEAR WATER BASIN, HUDSON, N. Y.

A 6-in. waste pipe connects both the filter and the clear water reservoir with the sewer.

The water is pumped through a 16-in. force main directly to the filter. I believe it was Mr. Rand's idea to have a settling basin for sedimentation, and the weirs for aeration. Why the settling basin was omitted, I have never been able to find out. Mr. Rand also recommended covers for the filter, but they were never built.

In 1888 it became necessary to have more filtering capacity, and a new but larger filter was constructed after the plans of the old one. The area of this new filter is 23,017 ft. at the surface of the sand.

The present water consumption of Hudson is 1,500,000 gallons daily, or 150 gallons per capita. The total filtering area is 32,088 sq. ft., which, if the beds were in good order, is sufficient to properly filter the unusually large per capita amount of water which is used and wasted in this city.

Through neglect and ignorance, both of these filters have been allowed to become clogged and filthy, until their efficiency has been greatly reduced. During the summer months, when the beds can be cleaned often, the results are fairly good. In the winter, when the basins are covered with from 10 to 24 ins. of ice, and we are unable to clean them for periods of sometimes nearly 4½ months, the results are what is to be expected—very bad. The city has been brought to realize this, and steps are being taken to secure a new supply, or to improve the present plant by remodeling the filters and pumping station. An investigation and examination is being conducted that, we hope, will result in a speedy remedy of our present evils.

The existing plant can be made to give very good efficiency by the addition of sedimentation and aeration, with covers for both filters to permit them to be cleaned in winter months.

COST OF OPERATION.

The dirty filtering material is removed from the beds by wheelbarrows and the clean sand is replaced by the same means. The cost of removing, washing and replacing the sand from 1 sq. yd. of filter bed is as follows:

	Filter—Old.	Filter—New.
Removing, a sq. yd.	$0.00841	$0.01074
Washing, a sq. yd.	.00841	.00844
Replacing, a sq. yd.	.00807	.00920
Total	$0.02489	$0.02838

Assuming that 1 in. of sand is removed and replaced each time, we have $0.925 per cu. yd. as the cost of removing, washing and replacing the sand from the old filter and $1.02 from the new.

COST PER MILLION GALLONS.—The following cost per million gallons is based on the expense of operation and number of gallons filtered for the years 1898, 1899, 1900 and 1901: Total, including the salary of the watchman, $5,514; million gallons filtered, 2,185; cost per 1,000,000 gallons, $2.52, or only $1.56 if we take out the wages of the watchman when not actually engaged in filtering.

As we do not clean the beds for four months of the year, an addition of 50% should be made to the above figures to get the true cost per million gallons based on cleaning during the entire year.

During the spring, summer and fall months cleanings are made from two to three weeks apart, as the state of the water in the river may require. As both filters must be filled, after cleaning, with raw river water, the periods between cleaning during frequent freshets in the river are much shortened.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

The extent to which the technical school graduate has pre-empted the field of engineering work is well illustrated by a tabular statement made by Mr. Wm. Barclay Parsons, M. Am. Soc. C. E., in his recent report as Chief Engineer of the Board of Rapid Transit Railroad Commissioners of New York city. In this statement Mr. Parsons gives the number of men employed in the engineer corps of the commission, divided according to work and according to whether they are or are not technical school graduates. He also gives the number and names of the schools whose graduates are represented in the corps. The figures, briefly summarized, are as follows:

	Graduates.	Non-graduates.	Graduates, per cent.
Chief engineer	1	..	100
Deputy chief engineer....	1	..	100
Division engineers.....	5	2	71.4
Assistant engineers	93	16	85.3
Rodmen.....	33	12	73.3
Axemen.....	11	19	36.6
Total	144	49	74.6

Including engineers only, by omitting the 75 rodmen and axemen, it will be seen that of the 118 employed 100, or 84.7%, are technical school graduates. The number of technical schools which are represented by graduates among these 193 men is 42, of which two are Canadian and two others European institutions, the remaining 38 being divided among 16 different states of the United States. The greatest number of men from any one school is 29, from Columbia University, in New York city, which is also the alma mater of Chief Engineer Parsons. All of the positions below the grade of division engineer were filled after competitive examination by the Municipal Civil Service Commission. There are few engineers today, we imagine, who will dispute the value of collegiate training for engineers; and although criticisms of the work done by the engineering schools are numerous, such figures as those quoted above demonstrate that technical school graduates succeed in obtaining positions in open competition with the men who have not had such training.

Nearly a year ago, in our issue of Sept. 19, 1901, we discussed the subject of "Engineers and Patents," and stated that the old view that it was unprofessional for an engineer to take out patents on inventions which he might make had been largely abandoned.

Since that time the question has been well threshed out in the American Society of Civil Engineers, first in the discussion of a paper on "The Antecedents of the Septic Tank," by Mr. Leonard Metcalf, and later in a paper entitled "Is It Unprofessional for an Engineer to Be a Patentee?" by Mr. Archibald R. Eldridge. The latter paper, with the discussion upon it, has been separately reprinted; but we presume most engineers will be satisfied to accept the final conclusion as set forth by the author in closing the discussion. We quote as follows:

> The writer feels confident that the question is now settled, and that an engineer can patent any article which he may invent, and that he can dispose of the right for using the same, but always "openly and above board," without violating the ethics of one of the most honorable professions of the time.

The long controversy as to whether a cable across the Pacific should be laid by the United States Government or by a private corporation appears likely to be finally settled by a grant to the Commercial Cable Co. On Aug. 9 President Roosevelt made public the terms on which this company may receive the permission it desires, and although these terms contain several features which the company will probably regard as severe, it is likely to accept them in order to have the work under way as soon as possible before a new session of Congress begins, with new agitation for Government construction of the cable.

Without taking space to review in detail the terms laid down by President Roosevelt, it may be said that under them the Government will be in quite as advantageous a position strategically as it would if it were to lay and own the cable. So far as profit is concerned, it is quite likely that the cable company can make a good profit on what would be a losing venture under Government management. No doubt Government ownership of telegraphs by both land and sea is one of the things which the future will bring forth; but to start such a change on a piecemeal plan would be like beginning Government ownership of railways by building a small isolated line and attempting to operate it without connection or traffic arrangements with other railways.

It is curious how fallacious ideas with regard to matters of engineering or commerce frequently take a strong hold on the popular fancy and by continued repetition in the newspapers come to be generally believed. A good illustration is the paper project, of which more or less has been heard for a dozen years, to build a port to rival New York at the eastern end of Long Island. The absurdity of this project was well set forth last week by Vice-President J. P. Green, of the Pennsylvania R. R. A conference was in progress between officials of the Pennsylvania R. R. and New York city respecting the terms of the franchise for the new tunnel entrance to New York city, and a New York alderman remarked that the Pennsylvania might use this tunnel to carry freight to Montauk Point and build up a great transatlantic steamship terminal there. The "Tribune" quotes Mr. Green as making the following reply to this suggestion:

> This looks to us like the wildest dream. No sane man ever thought or dreamed of taking commerce out to Montauk Point. You could no more take commerce away from New York than you could take the blood out of your body and live. Montauk Point never will be a terminus. It is absurd even to discuss it. Mr. Corbin was too sound and sane a man ever to have dreamed of it. There is no more chance of the Pennsylvania Railroad doing that than there is of my flying over a house. It has taken 30 years to build up Newport News and make a port out of it, and it would take 3,000 years to build a terminal at Montauk Point. It is cheaper to carry freight from New Jersey to Long Island by water than by rail.

In one point only is Mr. Green in error. The late Austin Corbin did have a pet project for building a shipping port at Fort Pond Bay, near the eastern extremity of Long Island, but his plan was to have it made a "free port," into which materials for manufacture could be brought from any part of the world without the payment of duty. On this basis he believed a great manufacturing city could be built up there for the production of goods for export trade.

So far as traffic advantages alone are concerned, as we pointed out in these columns years ago, the Montauk Point project has always been an absurdity. Railway and steamship lines only go where traffic awaits them. The ports which really rival New York are those which have a shorter rail haul from the West. To carry export traffic past New York would merely add to the rail haul for the sake of reducing the steamship voyage, and would add to instead of decrease the cost of transport.

In our issue of July 3 we commended the action of the New York city authorities in canceling the insurance on buildings owned by the city and gave briefly the reasons why fire insurance should not be carried by municipalities. Our contemporary, "The Insurance Press," criticises our position and says:

> The fact must have come under the observation of the "News" that the losses by fire vary greatly, year by year over the whole United States. When such small areas as single states or single cities are considered the variations are violent.

Well, suppose the variations *are* violent. The rule which we laid down, and whose soundness can hardly be questioned, is simply that a city or corporation or individual should insure only property on which it cannot conveniently endure such variations of loss as may occur from year to year. In the case of New York, with its annual revenue and expenditure approximating one hundred million dollars, any possible loss by fire on city buildings would make an inappreciable difference in the tax rate, even if the losses in any one year were all added to the tax rate of the year following. With the financial system in force in New York, however, by which expenditures are largely provided for by bond issues, variations in the annual expenditure to make good losses by fire are already provided for and insurance is absolutely useless.

Our contemporary tries to make out its case by quotations from various Iowa newspapers in which the state government is criticised for not insuring state institutions. Subjected to analysis, these criticisms amount merely to this: (1) That during a particular period the losses sustained exceeded the premiums that would have been paid for insurance; (2) that some difficulty was found in providing funds for the prompt rebuilding of certain state institutions which were burned.

So far as the first of these criticisms is concerned, it is self-evident that in the long run the insurance premiums must amount to much more than the losses by fire.

The second point is really an argument, not for insurance, but for such changes in the public financial system as will make it possible to meet such emergencies without difficulty. One way of doing this is for a city or state or company to keep a special insurance fund, paying into it such amounts as would be charged by an insurance company, investing the amount in safe securities and taking from the fund whatever is necessary to make good the losses by fire. We commend this plan for adoption in any case where public opinion is not sufficiently educated to appreciate the wisdom of dispensing with insurance on public buildings.

AMERICAN COMPETITION WITH GREAT BRITAIN IN STEEL CONSTRUCTION.

> The idea that American bridge work is necessarily of the "cheap and nasty" class must be put one side altogether. The author's experience of first-class American bridge work is that it is fully equal, if not superior, to the best English work, in design, material, workmanship and finish.

We quote the above frank and generous compliment to American bridge engineering practice from the opening paragraphs of a recent paper read before the Institution of Civil Engineers.

A person's memory need not be a very long one to recall a time when one would have searched far on British soil to find an English engineer who

would not roundly condemn American bridge practice. The contrast is indeed striking when such a compliment as that above quoted finds expression by an English engineer in that typical center of British conservatism, the Institution of Civil Engineers.

The paper in question was written by Mr. Henry R. Molesworth, M. Inst. C. E., a London consulting engineer, and is entitled "American Workshop Methods in Steel Construction." Nearly the whole of the paper is devoted to a description of the plant, equipment and methods of the well-known Pencoyd Bridge Works, with some brief and limited comparisons with English practice.

As many of our readers will remember, this plant was very fully described in these columns some four years ago (Sept. 29, 1898), and we shall not attempt to reprint or abstract Mr. Molesworth's description. What is of more interest to American engineers is the comparison between the practice of the two countries, brought out partially in the paper but much more fully in the long discussion which followed.

This discussion was notable, by the way, for the amusing revelation it gave of how rigid conservatism still survives in some quarters on the other side. One old-time bridge builder, for example, said contemptuously that the Pencoyd Works was not a bridge building shop at all. It was simply a place where certain girders and pieces of girders were made, which, when carried away, could be built into bridges. In England bridge manufacturers were required by engineers (rightly or wrongly—he though rightly) to make bridges and erect them at the shops and then take them down and put them up in the place where they were to stand. The same member wound up his speech with the sarcastic remark that some Englishmen were still prepared to stand on their merits, and believed that in the long run, if the consumer wanted something good, he would go to England for it.

In opposition to such examples of old-school conservatism as the above, however, there were numbers of bright and able men who had studied and appreciated American practice and who pointed out plainly the various handicaps under which the British builder of iron and steel structures labors.

One notable comparison, which we do not remember having seen made anywhere before, was a statement of the average annual output per man employed in various capacities, first in the Pencoyd Works, and second in a typical British bridge shop. We print the table for the Pencoyd Works as follows:

Statement Showing the Output Per Man Per Annum in Tons of 2,240 Lbs. at the Bridge Department of the Pencoyd Works.

Year.	Drafts-men.	Templaters.	Bridge-shop.	Forge.	Eye-bar shop.
1895.....	967	2,203	108	35	158
1896.....	871	1,960	109	43	141
1897.....	695	2,220	134	38	208
1898.....	728	2,596	114	45	161
1899.....	665	2,598	120	42	210
1900.....	721	2,442	107	51	227
1901.....	753	2,545	114	59	190
Average	771	2,366	115	45	185

Note.—The output per draftsman and per templater is arrived at by dividing the total output of the works by the number of men employed. The output of the men employed in the bridge-shop, forge and eye-bar shop, is arrived at by dividing the output of each department by the number of men employed in that department.

In England, according to the author, the usual output per man is for draftsmen, about 1,000 tons; templaters, about 500 tons, and men in bridge shop, 20 to 30 tons. It will be seen that the English bridge builder gets along with a little smaller drafting staff than an American works would require for a similar output, but he employs from four to five times as many template makers and three to five times as many men in the bridge shop.

We have seldom seen a better illustration of the advantages of the modern system of manufacture, under which the drafting room does all the planning and leaves nothing for the shop to do but carry out the work as ordered. It is quite evident from the above figures that the conservative British manufacturer has hesitated to adopt the modern system. He has worried along with the fewest draftsmen possible, and those, we suspect, for the most part underpaid, ill-trained and incompetent. But as a result of the inadequacy of his shop drawings, he has to employ four times as many template makers as his American rival. His force of template makers, in fact, is nearly twice as numerous as the American's force of draftsmen; and when the material used and space occupied are considered, the template makers are probably the more expensive, man for man.

Other features of the discussion brought out pretty clearly the fact that many English bridge manufacturers have no conception of the American system of making complete working drawings for bridge work. One old-time bridge builder, after criticising English engineers for putting absolutely unworkable requirements in their specifications and making drawings which caused the bridge builder great delay, remarked that the designs for the Uganda R. R. viaduct from Sir Alexander Rendel's office were so plain that no working drawings were required, and 5,000 tons of material might be ordered from the designs in one morning.

Now, it happened that the author of the paper was at Pencoyd when these very drawings were received there, and he replied that instead of ordering 5,000 tons of material at once the Superintendent turned these drawings over to the drafting room and had about 200 sheets of detailed working drawings made before ordering a pound of material.

It appears to us that here is the real key to the much-discussed requirement in British bridge specifications that the structure shall first be erected complete at the manufacturer's works and then taken apart and shipped. With the responsibility for the design and details divided between a set of cheap draftsmen and another set of more or less inaccurate template makers, erection at the shops, where errors can be discovered and corrected, appears by no means an unnecessary requirement. Thus we see another way in which penny-wise economy in the drafting room proves pound foolishness at later stages in the manufacturing process.

The question is often asked: When American shops compete so successfully with their British rivals in working plates and shapes into the form of a bridge, why can they not compete with equal success in working similar plates and shapes into the hull of a ship? The above comparison, it seems to us, may give some hint of the answer to this question. American bridge-building practice proceeds on its own lines; American ship-building practice proceeds on lines almost identical with practice abroad. The use of drawings instead of templates cannot be carried to any such extent on the complicated surfaces of a ship's structure as on a bridge or building. Templates in ship work are as necessary here as abroad, and the wholesale builder of freight steamers on the Clyde or the Mersey who can use a single set of templates for half a dozen vessels has a great advantage over an American builder who builds no two ships alike.

Returning to the comparison of bridge manufacturing methods, of course the greatest contrast, so far as its influence on the total cost of the work is concerned, is found in the output per man employed in the bridge shop. At Pencoyd the average output for seven years per man employed in the bridge shop is seen to be 115 tons. In England it is only 20 to 30 tons. Part of this difference is due to the workmen themselves and part to the superior tools and systems of wofk which are provided here. Possibly, some difference may be accounted for by the class of work turned out running heavier in section. The final result, however, is that American workmen are paid double, or more than double, the wages paid their English rivals, and the manufacturer, after underbidding his foreign competitor and paying the charges on his plant, has a handsome profit remaining.

It will doubtless be said, however, that all this relates to past conditions, and not the conditions of the present or of the future. At present, we need hardly say, the phenomenal industrial activity in this country, coincident with an era of low prices and dullness abroad, has for a time checked the flow of American exports and started a current in the opposite direction. All recognize, however, that this condition is temporary only. Sooner or later the consumption of iron and steel produced in the United States will fall to a normal figure, and a market for the large surplus product must then be sought in foreign countries. In the international competition which will then take place, America can by no means count upon an easy victory. The object lesson given by America's industrial successes during the past half dozen years has been diligently studied by our foreign rivals. The "Americanization" of British and German iron and steel works and machine shops is going on all the time. Labor unions here are increasing their restrictions and tending to make conditions as onerous as those abroad.

The prospects are that on our next entry into the international iron and steel market our chief advantage will be our cheaper raw material and the greater scale of our operations, while to offset this we have the handicap of a greater distance to the markets of the Old World than our European competitors.

THE THIRD-RAIL AND TROLLEY-WIRE SYSTEMS FOR INTERURBAN ELECTRIC RAILWAYS.

In the development of the long-distance and high-speed electric railways, which are becoming such an important feature in local transportation, there has as yet been but a limited adoption of the third-rail system of current conductor. Partly on account of the fact that these railways are a development of the street electric railway, the natural tendency has been to continue the use of the overhead trolley wire. But besides this there are certain objections to the third-rail system, in which the "live" rail is readily accessible, and is therefore more dangerous than the overhead wire. The third-rail system is used only on lines having their own right of way, which is closely fenced in, and the rail is broken at level crossings, connection being made by an underground cable. Yet fences and cattleguards are not sure preventatives against trespassing, especially on the part of curious or mischievous persons, and it remains to be seen how much serious danger there is in the use of the third rail.

One of the reasons given for the use of this system is that the trolley-wire system is not so well adapted for high-speed service, but as a matter of fact many high-speed trolley lines are in operation and experience little trouble from the trolley leaving the wire; in fact, probably no more trouble than is experienced on city lines. On the lines of the United Traction Co. of Indiana (154 miles) the trolley system is used exclusively, and the cars are run at schedule speeds of 40 to 45 miles an hour, while speeds of 50 to 60 miles an hour are not infrequently attained. Yet the trolley very rarely leaves the wire. On the other hand, the third-rail system is considered as a general improvement upon the trolley-wire system for railways of this class, and the cost of maintenance will probably be very much less than for the overhead construction required to support the trolley wire, especially where there are numerous curves, switches, etc., which require a more or less complicated overhead special construction.

The Albany & Hudson Railway & Power Co. operates a line between Albany and Hudson, N. Y., a distance of 38 miles. Through the cities the trolley system is used, but outside of the cities (where the line is laid on a private right of way) the third-rail system is used. The business resembles that of a steam railway, and all classes of steam railway cars are hauled over the line. The reason for the adoption of the third-rail system in this case was the very crooked condition of the line, and it was feared that a high speed could not be maintained with an overhead trolley wire. The traffic is also very heavy at times, and the third rail is said to have proved a much better conductor than the trolley. A current of 550 volts is carried in the third rail.

The cars are operated at an ordinary speed of about 25 miles per hour, but a speed of 60 miles an hour is often attained, and we are informed that even a higher rate of speed than this is occasionally made on straight and level track. The line is fenced with a woven-wire fence the entire distance. At highway crossings, cattleguards are placed to prevent animals and persons from getting on the right of way; and a sign is also placed on each side of the highway, reading, "This railroad is operated by an electric rail; walking upon the track or other trespassing is forbidden." At

all farm crossings, cattleguards are used to prevent stock from getting upon the right of way when being driven across the track at such points.

Since the road began operation, two persons have met their death by coming in contact with the third rail. The first case was that of an old man, who was in very feeble health, and it was shown that he had fallen down several times during the day on the streets of Albany and that he was not in a physical condition to withstand any shock, and it is considered an open question whether he met his death by coming in contact with the third rail or whether he had fallen in a fit and was found dead on the rail. The next case was that of one of the car conductors, a man about 60 years of age, who was out in a thunder shower, his clothing being thoroughly soaked. While performing his work, he slipped and fell backwards, striking the back of his head on the third rail, his body lying across the main track rail. In this case, we are informed, it was a question if the blow on the back of his head did not have more to do with his death than the shock from the third rail. A few animals have been killed by coming in contact with the third rail. This record would seem to show that the third-rail system is not so dangerous as is sometimes supposed.

At first there was a little trouble from boys and others tampering with the third rail, by short-circuiting it with short pieces of wire and other pieces of metal. This trouble was very slight. On one occasion the third rail was short-circuited by some mischievous person placing a splice bar from the third rail to the main track rail; this caused a temporary shut-down of about 30 minutes. Aside from this, there has been no trouble from this source.

The most recent case of the adoption of the third-rail system is the line of the Aurora, Elgin & Chicago Electric Ry., about 80 miles; and on this road the third rail is laid through several towns along the route. It has its own right of way entirely, but crosses numerous streets and roads at grade, and there is some anxiety in these places as to the liability of accident, especially to children. This road is intended for high-speed service, and is almost ready for traffic. The third-rail system is also used on a part of the New York, New Haven & Hartford R. R., but we have no information as to the number of accidents due to the "live" rail. On the elevated railways of Chicago and New York the same system is used, and accidents have occurred to men working on the lines, but of course these tracks are inaccessible to the public.

LETTERS TO THE EDITOR.

Laboratory Tests of Draft Gears.

Sir: It seems to me that the strictures in your editorial page of July 31, on the value of laboratory tests of freight car draft gears were justified in part, so far as they apply to tests for ascertaining the ultimate strength of draft gears. In testing the ultimate strength it is difficult to provide a method of attachment of the stronger gears which will develop their full strength. Serious weakness of follower plates, etc., is however developed in many cases.

Apart from the matter of the test for ultimate strength, there are many elements of the working resistance of these gears which are are made evident in static laboratory tests. I refer to such elements as the work absorbed at the time the gear becomes solid, the character of the release and the extent of motion under light running shocks. The relative value of different designs of friction-draft gear is to be fixed mainly by the character of the load-deformation diagram obtained under a static test. The more nearly the test curve of a friction-draft rigging approaches the character of Fig. 4, p. 77, in the issue quoted above, the better its design. Yours truly,

W. K. H.

Washington, D. C., Aug. 6, 1902.

A Cheap Concrete Steel Highway Bridge.

Sir: Enclosed is a photograph of one of our concrete-steel bridges just completed in Wabash county, Ind., designed according to the method described in Engineering News of May 8. The span is 25 ft., width of roadway, 16 ft.; thickness at crown, 8 ins.; of gravel concrete, 1 cement to 7 gravel, 2-in. gas-pipe railings. It was designed as a cheap but substantial highway bridge, and guaranteed flood proof on account of pavement in bed of stream. Contract price was $573, in competition with steel bridges and plain concrete culverts, of same span and roadway, the lowest bid on steel being $665 and on plain concrete $943. Forms were removed six days after completion, and traction engines passed over ten days after completion. Reinforcing steel rods were ¾-in. spaced 18 ins. c. to c.

Laselle Concrete-Steel Highway Bridge, 3½ Miles Northwest of Wabash, Ind.
The National Bridge Co., Contractors.

Very truly yours,

Daniel B. Luten, President
The National Bridge Company.

Indianapolis, Ind., Aug. 2, 1902.

A Locomotive Boiler That Went Up When the Crown-Sheet Came Down.

Sir: The boiler of B. & O. engine No. 1944 exploded while standing on the siding near the depot at Ravenna, O., on July 23. The boiler left the trucks and was carried forward a distance of 70 ft., the front end burying itself in the ground 5 ft. The engineer was killed. The fireman states that shortly after the train stopped he and the engineer and flagman were sitting on the main track just opposite the back end of the tender engaged in conversation. After some time he left them to attend to the fire and on returning told the engineer that as he had three gages of water he had better go and turn his blower off. The engineer got into the cab and almost instantly the explosion occurred. The flagman substantiates this statement and further says he heard the injector working while they were sitting there. Both men agree that the water had been on about 15 minutes. The crown sheet was turned inside out. The sheet shows a large burn in the center, but it is said by railway employees that the engine had been fired up while in the shop at the time with no water in the boiler.

The engine was a heavy 8-wheel hog, and was originally P. & W. No. 69, but it had recently been in shop for repairs and while there was renumbered. It was built at the Pittsburg Locomotive Works in 1900. There are a number of engines of this type in use on this road and the writer was told by a trustworthy informant that a large percentage of them had been burned.

The mate to this engine, No. 68, exploded three days later at Connelsville, Pa.

A stay-bolt, now in possession of an ex-engineer at Ravenna, shows corrosion and also an old fracture of about half its diameter near the head. Many of the bolts showed more or less the action of the fire at the point where they entered the sheet. The interior of the boiler was scaled to a considerable extent, a bolt-head in a brace showing fully ⅛-in.

If the statement of the crew can be relied upon, it is the opinion of the writer after a careful examination that the failure was caused by a weakened condition of the sheet and stay bolts rather than by low water, though low water was the cause assigned by the railway officials.

If the explosion had occurred two minutes later a through passenger train would have been alongside.

The steam gage indicated 140 lbs. just before the explosion. Very truly yours,

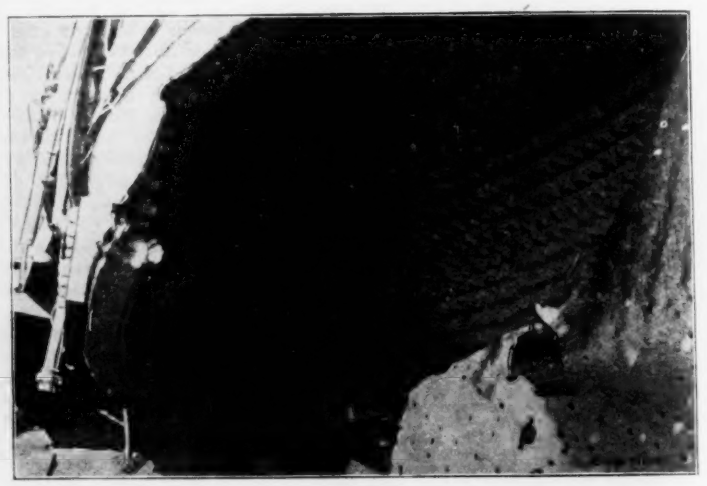
F. R. C.

Ravenna, O., Aug. 4, 1902.

(Railway officials, as a result of long experience, take a burned crown-sheet as prima facie evidence of low water, and it takes very strong evidence to the contrary to change their verdict. The statement that the mate to this engine exploded only three days later, however, indicates at least a possibility that something was wrong with the design of these engines.

Direct criticism would be inappropriate in the absence of more specific information. We may point out, however, that boilers with flat crown-sheets are generally considered more likely to blow out the whole inside firebox as a result of low water than boilers of the radial stay type, where the center of the sheet gets hot and the stay bolts pull through and relieve the pressure, while the sheet and bolts at either side of the center are still cool and holding well.—Ed.)

General View of Wreck.



View of Interior of Firebox.

VIEW OF EXPLODED BOILER OF B. & O. LOCOMOTIVE, NO. 1944.

Notes and Queries.

A fault in the press-work in printing the article entitled "Some Recent Experiments with Cements, Mortars and Concretes," in our issue of July 24, rendered the first column of Table VII. illegible and we reprint the table herewith as follows:

TABLE VII.—Showing Effect of 1/16-in. Common Iron Wires in Neat Portland Cement Briquettes, 1 Day in Air and 6 Days in Water.

No. of wires in briquette.	Co-efficient.	Tensile strength—Actual, lbs. pr sq.in.	Tensile strength—By formula.	Average No. of tests
0	1.000	669	669	26
1	1.02194	671	683	23
2	1.04298	691	698	22
3	1.06447	730	712	12
4	1.08596	749	727	20
5	1.10745	782	741	20

LOOP TERMINALS AND TRANSFER STATION; METROPOLITAN ELEVATED R. R., CHICAGO.

The advantages of loop terminals over dead-end terminals for elevated railways, with their heavy traffic, have several times been pointed out, but the first road to adopt this system is the Metropolitan West Side Elevated R. R., of Chicago, which has recently completed a loop terminal at the end of its Douglas Park line, and is now building a similar terminal at the end of its Garfield Park line. It also intends to build loops at its other outlying terminals. With the loop system there need be no holding of trains outside the station during the busy hours, caused by a slight delay of a train at the unloading platform, which delay in the case of a dead-end terminal necessitates holding all incoming trains until the offending train has backed out in the face of these trains. The dead-end terminal at a transfer station with continuous track would also entail an inconveniently long walk on the part of passengers from one train or car to another. The great advantage of the loop lies in the fact that it eliminates all switching and reverse movements, the trains moving ahead all the time and following each other closely. The present end of the Garfield Park line is a dead-end station at 48th Ave., but a new station, with single track loop connecting the inbound and outbound tracks, is now being built on the street level at 52d Ave., approached by an incline with a grade of 0.9% from 48th Ave., as described in our issue of July 31.

This station will be used as a transfer station for passengers on the trains of the Metropolitan Elevated R. R. and those on the interurban cars of the Chicago, Aurora & Elgin Electric Ry. This latter line is a double track surface road, built on its own right of way and intended to be operated at high speeds, using the third-rail system. At some later period the interurban cars may perhaps be run over the line of the elevated railway to the business district of the city, but no such plan is yet contemplated, and passengers will therefore transfer at 52d Ave.

Beyond the foot of the incline there are four tracks, 12 ft. c. to c., the two outer tracks being used for storage. The two tracks on the incline begin to spread at the foot of the incline near 50th Ave., turning out to connect with the outer lines by curves of 1,000 ft. radius, as shown on the plan, Fig. 1. As these main tracks approach the station they again turn outward by curves of 500 ft. radius, followed by tangents leading to the semicircular terminal loop of 90 ft. radius. This loop has a guard rail with 2½-in. flangeway. The interurban railway has two main tracks which cross the loop at grade, and each of these has a turnout which runs parallel with the main tracks. On each side of the station is a triangular platform, having the elevated railway and interurban railway tracks on opposite sides. Thus, a Metropolitan train arriving from the city discharges its passengers at the same platform from which the interurban cars start. The train then runs around the loop to the other platform, ready to receive passengers who have arrived on an interurban car and wish to proceed to the city. The platforms are long enough for trains of five cars of the elevated railway. The interurban cars are transferred from the inbound to the outbound track of their road by a crossover with curves of 250 ft. radius.

There are two small station buildings of red pressed brick, one at each platform, the platforms being covered by umbrella roofs of corrugated iron supported by light steel columns and transverse trusses. On the north side of the station is an inspection house, 59 × 110 ft., with four tracks, in which motor cars may be stored and inspected. This is of red pressed brick, with steel roof trusses, and at one end is an upper story for the trainmen's room, from which a light plate girder bridge extends across the tracks, with steps to the platforms. Under the track at the inbound platform is an inspection pit, so that motors, etc., can be inspected without running the cars into the house. There is also an open yard with tracks for inspection or storage of cars, the tracks being reached by a trailing switch from the loop. On the south side provision is made for a larger car house with five tracks 13 ft. c. to c. The entire area of the station grounds is enclosed by a fence and access to the platforms can only be obtained through the ticket offices of the station buildings on 52d Ave. Passengers passing between the transfer station and the street or the 52d Ave. cars of the Suburban Ry. cross the loop and interurban tracks by means of suoways built of concrete, and having roofs of I-beams and concrete.

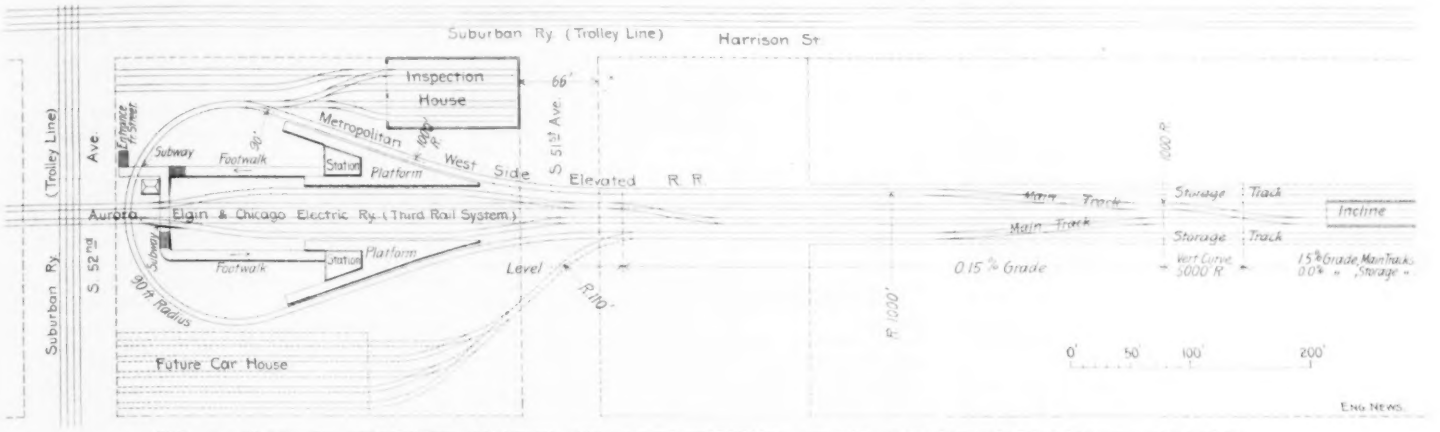


FIG. 1. PLAN OF TRANSFER STATION AND LOOP TERMINAL AT 52D AVE. AND HARRISON ST., CHICAGO.
W. S. Menden, Chief Engineer; Metropolitan West Side Elevated Ry.
C. Jones, Chief Engineer; Aurora, Elgin & Chicago Electric Ry.

The arrangement of this transfer station was planned under the direction of Mr. W. S. Menden, Chief Engineer of the Metropolitan West Side Elevated R. R., and Mr. C. Jones, Chief Engineer of the Aurora, Elgin & Chicago Electric Ry. For a plan of the terminal we are indebted to Mr. Menden. The construction work was done by Agnew & Co., of Chicago, except that all track work was done by the Metropolitan Ry.

The loop at the 4th Ave. terminal station of the Douglas Park line, already referred to, is on the elevated structure, as is the car yard at this point. A plan of this terminal is shown in Fig. 2. There are three tracks approaching the terminal, the middle one being for car storage; the two outer ones are the main tracks, which diverge and are connected by a curve of 90 ft. radius, forming a kite-shaped loop. Within this loop are 11 yard tracks, three of which run into the car shed or inspection house. At the outbound platform is an inspection pit, so that the motors and gearing can be inspected, oiled, etc., without sending the motor car into the house. At this pit the track rails are laid on timber stringers 6 × 12 ins., bolted to the top flanges of the plate girders. Around the curve there is an inside iron guard rail and an outside guard timber to the inner rail, while the outer rail has two guard timbers. At the terminals sets of switch timbers are used, ranging from 10 to 22 ft. in length, and tie-plates are placed under the rails. The entire surface of the yard is covered by planking laid upon the ties.

The station building on 40th Ave. and the car inspection house are both of red pressed brick. The latter is supported upon columns and girders, and has an upper floor with rooms for the trainmen; bridges and stairways connect this floor with the two station platforms. From the waiting room of the station there is a short stairway to elevated walks leading under the structure to the

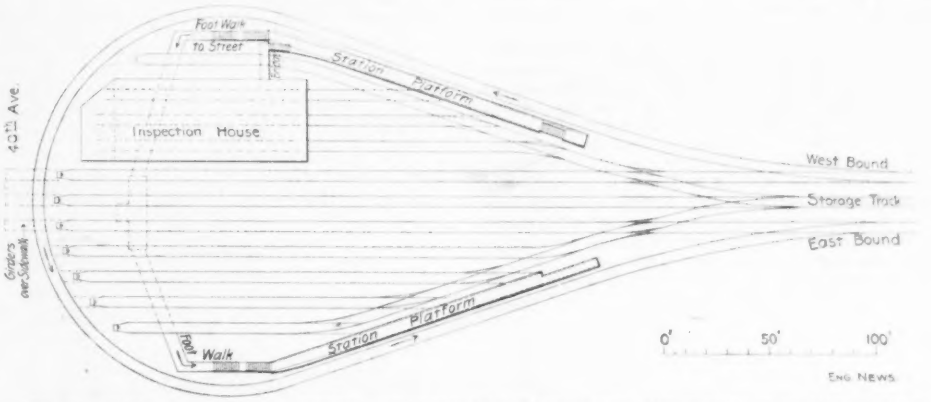


FIG. 2. PLAN OF LOOP TERMINAL OF DOUGLAS PARK LINE; METROPOLITAN WEST SIDE ELEVATED RY., CHICAGO. W. S. Menden, Chief Engineer.

The station building on 40th Ave. and the car inspection house are both of red pressed brick. The latter is supported upon columns and girders, and has an upper floor with rooms for the trainmen; bridges and stairways connect this floor with the two station platforms. From the waiting room of the station there is a short stairway to elevated walks leading under the structure to the platforms, which are reached by other stairways, as shown. The double line of girders for the 90-ft. curve is supported directly by a single row of columns under the center of the track. The other tracks have their girders resting upon transverse plate girders, supported by columns under the centers of the tracks. The main girders of the three middle yard tracks extend across the sidewalk in front of the station.

At the Marshall Boulevard station on the Douglas Park line of the Metropolitan West Side Elevated Ry. is a Reno inclined passenger elevator or traveling incline. The tracks and platforms at this station are at a considerable height above the street, as the structure crosses a steam railway

whose tracks have been elevated above the street level. The elevator is in two parts. The first extends from the station building to a bridge under the tracks which gives access to the stairways leading to both platforms. The second part extends from this level to the eastbound platform, which has the bulk of the traffic. Both parts of the inclined elevator are parallel with the usual stairways and have the same pitch or slope as the latter.

THE PENDING MARCONI-DE FORREST WIRELESS telegraphy suit promises to be interesting. The Marconi Co. has sued the De Forrest Co. for infringement of patents, diversion of large profits, an accounting, etc. On the other hand, counsel for the De Forrest Co. claim that the patents of their clients are so radically different that there can be no infringement; the Marconi system depending on "coherers," and the De Forrest system on "anti-coherers;" the one uses a continuous current and the other a secondary current. The De Forrest Co. claims that the latest Marconi coherer differs in no essential feature from the coherer described by Onesti, Branley, Hughes, Lodge and Popoff, and used as early as 1894 by Lodge for the transmission of electrical signals over short distances. They say further that the inventors of the anti-coherers system—Messrs. De Forrest and Smythe—started with the bare physical phenomenon discovered in 1899 by Neuschwender, who devised a crude apparatus that was non-sensitive and was utterly useless as a wireless telegraph receiver.

THE PROPOSED STANDARDIZATION OF CAST-IRON PIPES IN GREAT BRITAIN.

The British Water-Works Association has been considering the standardization of cast-iron pipes, and at its recent seventh annual convention a special committee presented an interim report on the subject. The first step of the committee was to obtain the views of 119 water-works engineers and pipe founders on the desirability and practicability of such standardization. Of 23 consulting engineers 21 gave unqualified and two qualified approval; of 75 "representative" engineers (officials in charge of works?) 68 gave unqualified and 5 qualified approval, while 2 disapproved; and 21 pipe founders unanimously approved the plan.

On the strength of these returns the committee felt warranted in outlining a proposed investigation of the subject, as follows:

(1) That varying standards should be adopted for varying pressures. In our opinion, there can be no doubt that this is essential if the standards are to be rendered capable of general application, but it is also evident that if manufacturers are to be expected to stock the standard pipes to any practical extent, the number of standards for each size of pipe must be kept as low as is reasonably possible.

(2) That the standards should be limited to the smaller diameters, as, for example, those under 16 ins. This point is one which requires careful consideration, but, in our opinion, it will depend very largely upon the relative quantities of each size of pipe required annually in the course of ordinary water-works practice. It would evidently be unnecessary and absurd to include large diameters, which are only required by some five or six undertakings throughout the country, and in which the conditions as regards water pressure, length of main, nature of soil, and amount of traffic over the line of the mains would vary considerably in each case.

(3) The standardization should extend to water fittings, rules and regulations, pipe flanges, specials, and coating of pipes. On this head we would remark that the questions of water fittings, and of rules and regulations to prevent waste, are being dealt with at this meeting by both the president and Mr. R. S. Lloyd, and, therefore, it is unnecessary for us to comment upon them here. In any case, however, we think that these questions would be better dealt with independently of that of cast-iron pipes. The standardization of pipe flanges has already been taken in hand by the Institution of Mechanical Engineers, and as this is a question which extends far beyond the limits of cast-iron water pipes, we consider that it should be specifically omitted from the investigations now under consideration. The standardization of special pipe castings is, of course, closely allied to that of cast-iron pipes generally, and should be carefully considered, together with all such kindred questions as coating, method of casting, and testing of pipes. There appear to be many points common to all classes of cast-iron pipes (as well as to all classes of pipe foundries) which might with advantage be incorporated in any scheme of standardization, but each would require to be considered on its merits.

(4) That in any scheme of standardization metric measures of weight and dimensions should be adopted. We are hardly prepared at the present time to give a final opinion on this point, but judging from the results of previous attempts to alter our national standards, we have little doubt that this suggestion will have to be abandoned as impossible, at any rate for the present.

(5) That solid lead joints should be provided for, as well as lead and yarn. This seems a matter which may fairly be left for further consideration, but we call special attention to it because it has been very strongly urged by Mr. Matthews (past president) and Mr. Baldwin Latham, and is therefore a point upon which some discussion would be of interest.

(6) That standards for any given size of pipe should be based upon external diameter rather than internal. We think it worth while to mention this point, as although to some extent a matter of detail, it is at the same time a question of such importance as to amply warrant some discussion on this occasion. The system proposed has been adopted by the New England Water-Works Association, of Boston, Mass., in the scheme of standardization recently promulgated by them. It offers the important advantage of rendering all spigots and sockets for a given size of pipe common to all classes of pipe under the different standards of strength, and, further, enables the pattern for any given size of pipe to be used in common for all classes, the variations in thickness being restricted to the core. The chief disadvantage appears to be the fact that the internal diameter would no longer be an accurate gage of the size of the pipe, but that thin pipes would be slightly larger than the nominal diameter, and thick pipes slightly smaller.

(7) That before adopting any definite scheme of standardization, the views of the leading consulting engineers and pipe founders should be obtained.

(8) That the whole question should be referred to a committee.

These proposals, being of a kindred nature, may be dealt with together.

It must, of course, be obvious that no attempt at standardization could be successful unless it had the sanction and support both of the leading water-works engineers and the principal pipe founders, and your committee strongly urge that before any details are decided upon, they should be submitted to all those most intimately associated with the industry in question, and as far as possible modified to meet any views that might be expressed by them. In fact, it appears—at least, for the moment—that the most effective procedure would be either by a general conference of all engineers and manufacturers interested in the matter or, should such a conference be impracticable, by some form of plébiscite.

The last section of the report reviewed the recent progress report of the committee of the New England Water-Works Association on the same general topic, and concluded with the following cordial remarks:

During the discussion (before the New England Association—Ed.) a letter from our secretary was read, suggesting co-operation between the two associations in regard to this and kindred matters, and your committee propose to do all in their power to facilitate a mutual exchange of opinions as well as of printed matter, in order that the water works engineers in both countries may mutually assist each other to the greatest possible advantage of both.

The members of the British committee are as follows: Frederick Griffith, President of the association, 1901-2; Wm. Watts, Past President; W. Pearson, Member Council. Mr. Percy Griffith, 54 Parliament St., Westminster, England, is secretary of the association.

EXAMPLES OF RECENT PRACTICE IN THE CONSTRUCTION AND EQUIPMENT OF RAILWAY ROUNDHOUSES.

(With two-page plate.)

At the annual convention of the Railway Master Mechanics' Association, held at Saratoga, N. Y., June 23 to 25, there was presented, under the title of "Up-to-Date Roundhouses," a committee report covering the subject of roundhouse construction and equipment according to most recent practice and experience in the United States. This report is so good a summary of modern practice in the line of work covered by it that we present a very full abstract with reproductions of many of the illustrations. The mode of procedure adopted by the committee was to have each member report upon a single phase or division of the subject previously settled upon and assigned him by the committee as a whole. The report, therefore, has the standing of a series of individual papers and expressions of opinion rather than of a single report modified and trimmed so as to express only those opinions mutually agreed upon by the members of the committee. This explanation is necessary to a clear understanding of the form in which the report is presented as follows:

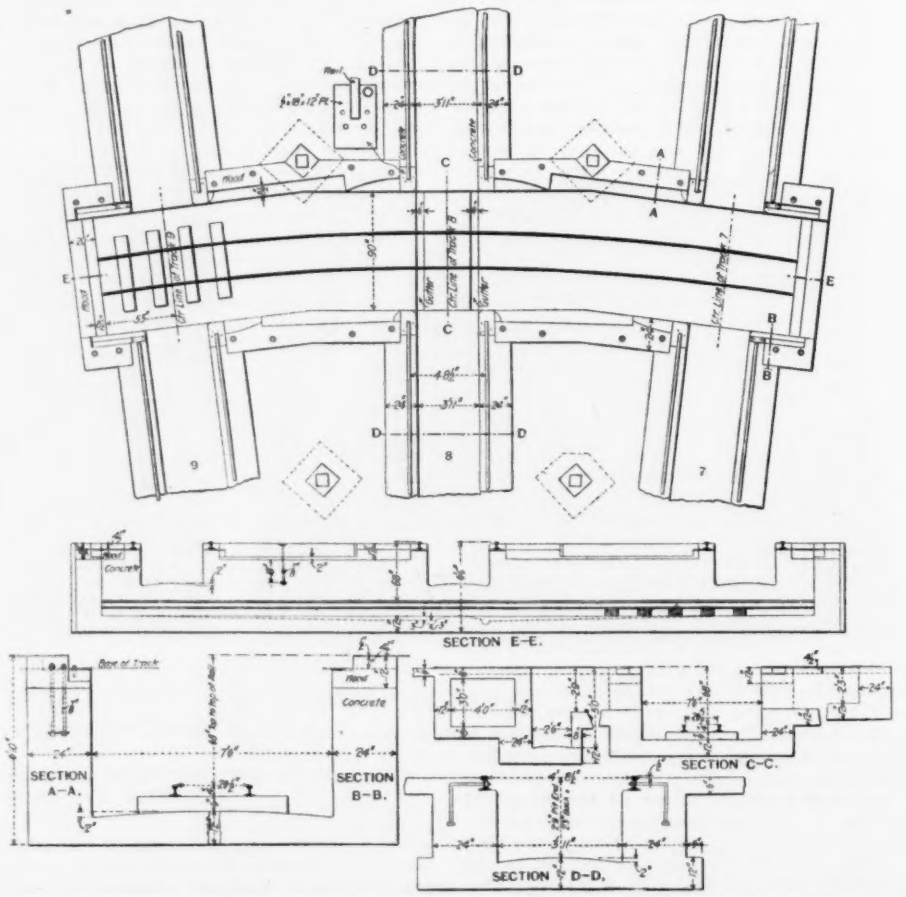


FIG. 17. CONCRETE ENGINE AND WHEEL PITS FOR ROUNDHOUSE AT ELIZABETHPORT, N. J.

PLANS OF TERMINALS RECENTLY CONSTRUCTED.
By Robert Quayle.*

I submit for your consideration, first: Fig. 1, which is a plan of roundhouse terminals at Clinton, Ia., on the

*Superintendent of Motive Power and Machinery, Chicago & Northwestern Ry., Chicago, Ill.

Chicago & Northwestern Ry. This plan I submit for the reason that it is flexible, and one, two, three, four or more roundhouses may be set in line. This part of the road runs east and west, and it is the opinion of the writer that the roundhouses ought to be set parallel with the tracks. At Clinton, Ia., two divisions terminate: the Galena division, which runs from Chicago westward to Clinton, 138 miles, and the Iowa division, which runs eastward from Boone to Clinton, 202 miles. These are the lengths of both passenger and freight divisions.

At a busy terminal, where there are from 200 to 350 locomotives a day to be handled, it is very necessary that engines should have track facilities that will enable the locomotive to be moved from the roundhouse up into the freight yard to be coupled on to its train without any interruption by the opposing movement of locomotives. It is also necessary to have an additional track that will enable the locomotive to come from the freight yard up and into the engine house without being detained by opposing engines. This not only holds true for freight locomotives, but also for passenger locomotives. Therefore let us consider Fig. 1. I will first call your attention to the movement of passenger locomotives from the passenger depot, and I do this because on some roads they use a better quality of coal for their important passenger engines than they do on their freight engines; consequently they have the coal better taken care of, broken up and placed on the tender in better condition, and for this reason it is necessary to have one side of the coalhouse given over to passenger coal, and hence it is necessary to have a track on the side of the coalhouse over which the passenger coal is to be delivered to locomotives set aside for passenger locomotives, and on this plan the northbound track, marked "A," is known as the track for the movement of passenger locomotives. The depot being to the east of the roundhouse, the engines cut off from their trains and come up through the yard west-bound until they enter upon track "A," on which they pass up to the coal chute and take coal, and immediately at the west end of the coal chutes is the sand tower, from which they take sand. They then pass on down to the stand-pipe and take water, and then move to the switch which gives them a clear way over their cinder-pits and into their respective roundhouses, whether they be Galena or Iowa division engines.

Your attention is next called to the passenger locomotive leaving the house and going up to the depot to be ready to couple on to train after its arrival. If the passenger engine is in the west roundhouse, which belongs to the Iowa division, it will pass out of the roundhouse on the track to the east of the roundhouse, and will pass over what is termed the ash-pan pit, and if the ash-pan needs cleaning it will be cleaned out and the engine will pass onward down toward the depot, connecting with track "A," where it has access to a stand-pipe, and can fill its tanks with water at that point, if necessary. When passenger engines go out from the east roundhouse they go down to the east-bound track and take water at the same penstock, and on eastward to the depot.

Now we will follow the freight engines from the point of giving up their freight trains to their arrival in engine house. First, be it understood, that the freight yard in this plan is to the west of the roundhouse and all east and west-bound trains terminate in the same freight yard, and as it is located west of the roundhouse they all have to come eastward past the coal chute on track "B," and then cross over to coaling track "C," where they will take coal and pass westward to the switch, and go into either east or west engine house in the same manner as described above for passenger engines. The freight engines will come out of each of the east and west houses in the same manner as shown above for passenger locomotives, except that instead of going up to the passenger depot they will only go to the first switch and then head up on track "A," and if there are no passenger engines to detain them on the coalhouse track "A," they will pass on said track up into the freight yard. But should there be passenger engines taking coal at the coalhouse on track "A," they will take track "D," which we will call the run-around track.

This plan could be extended indefinitely so far as relates to number of roundhouses. I would also call attention to the fact that this plan calls for a depressed track, of which the writer is in favor, as his experience during some severe winter weather has caused him to discount very materially the use of pneumatic hoists for such purposes. I would recommend that we should always have pits long enough to at least clinker two engines at a time.

I next present to you Fig. 2, which is a plan of the McKee's Rocks yard, on the P. & L. E. R. R. This, for the lay of the land, makes a very desirable plan, and is a good deal the same as the Clinton plans, except that the positions of the roundhouses are reversed. In other words, the centers of these roundhouses are almost at right angles with the tracks.

Your writer is of the opinion that ash-pits should be as close to the roundhouse as possible, particularly in the northern climate, for the reason that when an engine has to run six, seven, eight hundred or a thousand feet, the cold air that passes up through the firebox, even though the dampers may be closed before the engine gets into the house, is sufficient to cause the flues to leak, and this should be avoided wherever practicable. I believe the arrangement of the roundhouse and terminals shown by Fig. 2 to be a very excellent arrangement. There is one thing I find in this house, as well as in the Clinton house, namely, the tracks are in a straight line with each other across the turntable, which is not only desirable, but enables the roundhouse foreman to handle his engines that are going on to the drop-pits, or engines that have to be taken into the shops for repairs. He can couple an engine on to a dead engine in one of these stalls and pull it out on the turntable without having to get a rope, or pole or post of any kind to push. Many of us know how inconvenient it is to get an engine part way out of the house and then get your men with pinch bars and pinch her the rest of the way to the table.

The next plan is that of a single house, and I present to you Fig. 3, which shows the arrangement of tracks, roundhouses and other facilities for terminal at Collinwood, O., on the Lake Shore & Michigan Southern Ry. This plan is excellent and speaks for itself without much explanation. There is one thing, however, that perhaps is not necessary for a house of its present dimensions, even though the circle were completed, viz., the two in-coming tracks, with a clinker-pit on each track. In discussing this matter with the men who are handling the cinders and cleaning the ash-pans of the locomotives, they tell me that it is very much more desirable for them, as well as more economical for the company, to have but one pit, and to have it of sufficient length to take care of all the engines going into the house, and the man in charge of the clinker-pit can take better care of his men at one pit than he can at two pits, and I concur with this opinion. If 150 ft. in length is not sufficient and two crews of clinker-pit men are not sufficient, make the pit long enough so that three or four engines and three or four crews can work on the same pit. The second pit may be a good thing to have in case of emergency, no doubt, but from the experience of the writer he would not consider it necessary.

I notice on this plan that there are two out-going tracks as well as two in-coming tracks from the roundhouse. One can take his choice of having it this way or having one in-coming track with a long clinker-pit and one out-going track. I think that this general plan is most excellent and would afford, no doubt, the minimum of delay and the maximum of expediency. The next plan is Fig. 4, which is another Northwestern single roundhouse, or small plant. You will notice that this is only an 18-stall engine house, but ample room has been left for the extension to a complete circle. Fond du Lac being a terminal point, the engines come in from different directions, and on this plan we have a track leading from the north yard up into the engine house over which the engine passes and thence on to a clinker-pit 150 ft. in length. After the engine is clinkered, it passes down on the same track, taking sand and water as it goes into the house. The trains that come in to the south-end yard pass up toward the roundhouse and get the engines clinkered and take water and sand in the same manner. When the business at this plant will be large enough to justify handling more engines, we will require two out-going tracks, one in either direction.

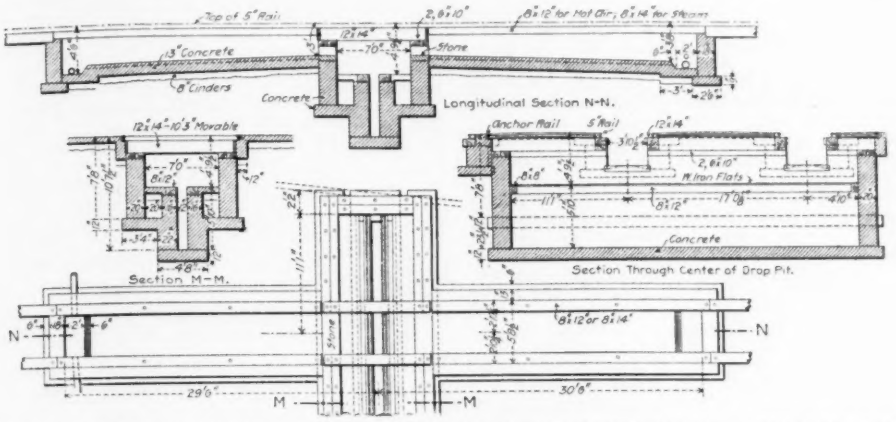


FIG. 18. CONCRETE ENGINE AND DROP PITS FOR NEW YORK CENTRAL & HUDSON RIVER R. R. ROUNDHOUSE.

THE IDEAL ROUNDHOUSE.

By D. Van Alstine.*

The ideal roundhouse, Fig. 5, is the one which handles engines with the least possible delay at the lowest possible cost. It provides in-bound tracks of sufficient length to store a large number of engines, on which are located coal chutes, sandhouse and cinder-pits. The coal chutes consist of 40 or 50-ton pockets on scales, into which hopper-bottom cars may be unloaded. The track above the pockets is reached by a 4% or 5% grade. At one end of the coal chute are the sand pockets, which are filled from cars the same as the coal pockets. After the sand is dried it is stored in elevated pockets, from which it is drawn into sand boxes. The cinder-pits are 150 ft. long and the depressed tracks are about 8 ft. below the bottom of the cinder-pits to allow of cheap loading of cinders into cinder cars. There should also be short cinder-pits in out-bound tracks for cleaning ash-pans of out-bound engines, and cleaning fires of switch engines. Stand-pipes should furnish water to engines on in-bound and out-bound tracks. The turntable is 70 ft. long and operated by power.

The roundhouse is 80 ft. long in the clear, with doors 12 ft. wide and 16 ft. high. It is heated by hot air from heater and fan, which passes around the houses through an underground duct on the inside circle, and is distributed to pits through underground pipes. The air to be heated is not taken from inside the roundhouse. A hot well into which is drained all the exhaust steam from the plant as well as steam from engines blow off furnishes hot water for washing out and filling up, and for stationary boilers. The power-house boilers are arranged to burn front end sparks where the price of coal makes it profitable. The engine room is provided with engine, dynamos, washout pumps, fire pump and air compressors. The machine shop is provided with lathes, bolt cutter, drill press, shaper, grindstone, planer, screw press, blacksmith forge and anvil. The storeroom contains all necessary

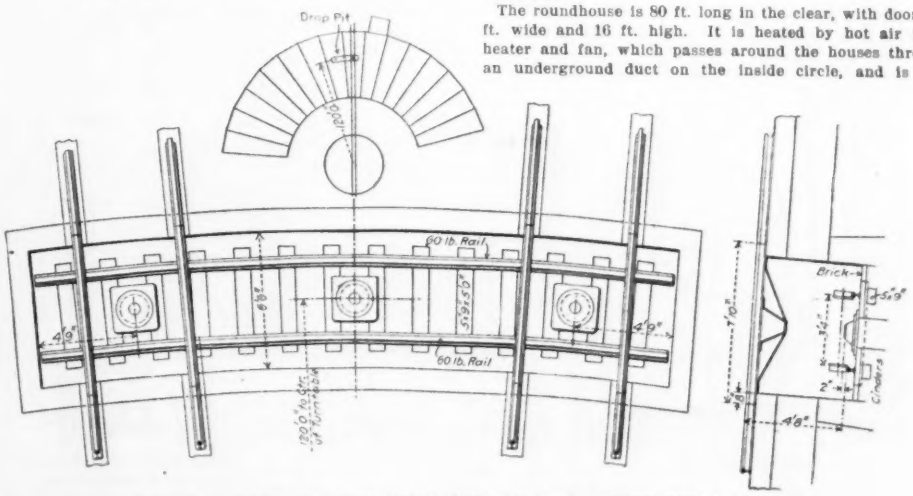


FIG. 19. DROP PIT FOR ROUNDHOUSE AT ELIZABETHPORT, N. J.

*Superintendent of Motive Power, Chicago Great Western Ry., Chicago, Ill.

supplies except oil, and a tool-room for small tools. The engineer's room is located close to the roundhouse foreman's office and contains bulletin boards and desk. The roundhouse foreman's office is centrally located. The lavatory is provided with wash basins, shower baths, closets and lockers for engineers, firemen and roundhouse men. The oilhouse should be conveniently located for taking oil cans to and from engines. In the roundhouse are tool racks between pits for pinch bars, wrenches and heavy tools, work benches on outer wall supported by brackets, drop pits for engine truck and driving wheels. An overhead track for lifting smokestacks, smokebox fronts, steam pipes, steam chests, pistons, cylinder heads,

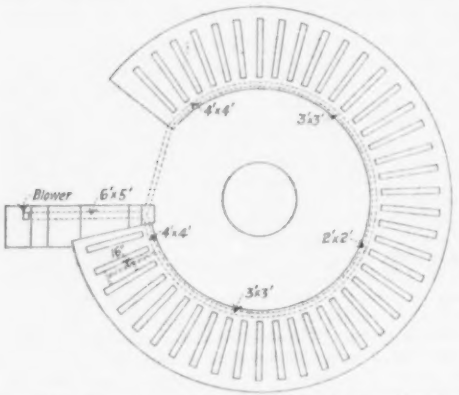


Fig. 20. Suggested Plan of Hot Air Conduit for Roundhouse Shown by Fig. 5.

cross-heads, etc., electric lights, electric and air motors for cylinder boring, etc. The overhead track has trolleys and chain hoists.

The drop-pits have hydraulic jacks on carriages for raising, lowering and moving wheels. The rod man is provided with a work bench on wheels.

A wheel storage yard is conveniently located for getting wheels into and out of the roundhouse. If fuel oil is used for fire kindling, a 6,000-gallon storage tank underground is located so that it can be filled from a tank car, and oil easily pumped from it for use in the roundhouse.

RECENT ROUNDHOUSES AND DETAILS OF CONSTRUCTION.

By G. M. Basford.*

GENERAL LAYOUT.—The Collinwood roundhouse of the Lake Shore & Michigan Southern Ry. is a good example of modern equipment, put into service the past year. Its equipment includes a shop, a storehouse, oilhouse and locker-room, as well as coal, ash, and sand handling facilities. Notwithstanding the close proximity of the largest repair shops on the road, the locomotive terminal was made complete in itself, in order to facilitate in every way prompt and efficient work on locomotives, to reduce to a minimum the delays and time out of service for running repairs, and other necessary work upon them. The general arrangement is shown in Fig. 3. Fig. 6 is a ground plan and section of the building, including the roof construction and location of the hot-air ducts and piping. Other details appear in other sections of the report. This house has an inclined wooden roof, with ventilators in the roof and two intermediate posts for roof supports. It is heated by a fan.

The Canadian Pacific fireproof roundhouse is illustrated in Fig. 7. The roof is inclined and is built of 18-in. I-beam, with two intermediate supports of 10-in. I-beams. The pits have 12 in. walls if of brick and 18-in. walls if of stone. On this road stone is preferred. This house costs about $1,650 per stall, exclusive of heating appliances and smokejacks, against about $1,300 per stall for the former standard, with brick walls and ordinary roofs. On this road steam pipes in the pits are used for heating. Fig. 8 represents a number of recently constructed roundhouses on the New York Central road.

The new Pittsburg & Lake Erie roundhouse at McKee's Rocks is illustrated in Figs. 9 and 10. This house has deep roof trusses and no posts. The heating is by a fan system, delivering into each pit from an underground duct. At the outer end of the section is a large ventilator, with generous openings. This roof truss gives 13 ft. 9 ins. head room at the inner end. Another duct, or tunnel, at the outer wall, contains 4-in. blow-off and hot water pipes. Steam and air are brought to each engine by 1½-in. pipes, carried on the roof trusses and dropping between the pits to a distance of 6 ft. 6 ins. from the floor. With this form of roof the natural lighting should be excellent. The monitor has 4 ft. 6 ins x 8 ft. louvres, spread 5 ft. apart and skylights in the mansard. The house cost about $2,200 per stall, including everything except the heating equipment. It has rolling steel doors.

The standard No. 1 roundhouse of the Chicago & North-Western, as constructed at Mason City, Ia., is illustrated in Fig. 11. It has a brick outer wall, wooden posts at the doors, and wooden roof and supports. The roof is made in two portions, with the vertical skylight between. This house cost $1,845 per stall, complete, except the heating apparatus.

At Elizabethport, on the Central R. R. of New Jersey, a new roundhouse, Figs. 12 and 13, with concrete walls, has just been put into service. It has concrete pits, an inclined wooden roof with three intermediate post supports. The heating is by a fan and underground duct.

At Du Bois, on the Buffalo, Rochester & Pittsburg, a 16-stall roundhouse has just been opened. It is shown in Fig. 14. This engraving illustrates the heater conduit, and gives a general idea of the construction of the house. The sectional view shows a wooden roof, which is incorrect, as the roof trusses are of steel, with a slate roof.

In connection with the new Denver shop of the Colorado & Southern, a new roundhouse, shown in Fig. 15, was completed last year. It has wooden smokejacks, a wooden roof with two intermediate supports, and a good arrangement for ventilation of the house. The house is heated by a fan system, with an underground duct, and besides the air duct is a subway for the piping. The roof construction costs about $60 per stall more than the ordinary flat roof.

At Nashville, Tenn., the Louisville & Nashville has installed a house, a section of which appears in Fig. 16. The intermediate supports of its roof, which is of wood, are extended to form the ventilator, which is 22 ft. wide, with slats in one side and ventilating windows on the other. The windows in the ventilator are valuable in increasing the natural lighting. This house cost $1,030 per stall, including the flooring, but exclusive of the pits and foundations. The pits and foundations cost approximately $400 additional, making $1,430 per stall, including foundations, pits and smokejacks.

PITS, AIR DUCTS, PIPE TUNNELS.—There seems to be nothing new to offer in the construction of locomotive pits, except the concrete construction of Figs. 17 and 18. There is an apparent preference in connection with fan-heating systems for the distribution of the hot air from underground ducts instead of from overhead metallic conduits, chiefly because the overhead system takes up valuable room and obstructs the light. In Fig. 10 one form of underground delivery is indicated, the hot air in this case passing into the ends of the pits. In Fig. 17 the air duct is below the floor, but the delivery is direct toward eight points in each pit. By using removable elbows and dampers the hot air may be delivered against the machinery of the locomotive or against the trucks of the tender for the rapid melting of ice or snow. In this construction, devised by Mr. George Hill, and used in the Elizabethport roundhouse of the Central R. R. of New Jersey, the entire heating system is out of the way and its construction is permanent. In addition to the pit outlets hot air is delivered into the roundhouse at each of the door posts. Heating conduits are again referred to under the subject of ventilation.

DROP-PITS.—Various plans for constructing drop-pits are indicated in the engravings. In addition to the usual driving wheel drop-pits, special pits for truck wheels are usually provided, and on the C., M. & St. P. Ry. a large pit, 8 ft. 8 in. x 10 ft., sufficient to drop a complete engine truck, is put into each of the principal roundhouses. In many cases the pits merely provide for lowering and raising the wheels, but the best practice provides for lateral movement of the wheels when lowered, so that they may be removed from under an engine and raised to another track, for removal to the shop. Stationary jacks

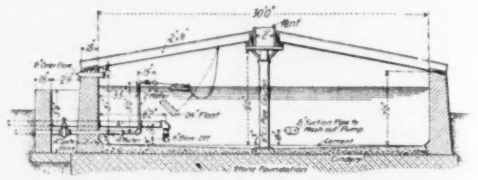


Fig. 21. Cistern for Receiving Blow-off from Locomotives at McKee's Rocks Roundhouse.

seem to be preferred. In Fig. 18 is illustrated the drop-pit, of concrete construction, of the New York Central, which is used in all new roundhouses. This pit serves two tracks, and reaches toward a third track a sufficient distance to permit of removing wheels at the end. The drawing shows the pit used with roundhouses of 418 ft. diameter. In some cases drop-pits have been built with a curvature to a radius from the center of the turntable. Those at Elizabethport of the Central R. R. of New Jersey and at Du Bois (see Fig. 19) on the B. R. & P., are so built. The drop-pit at Elizabethport takes in three tracks, which is advantageous. That construction is believed to be the best which provides for lateral displacement of driving and truck wheels with the least expense in masonry construction.

HEATING AND VENTILATION.—Nearly all large roundhouses of recent construction are equipped with fan systems, these being considered as furnishing the ideal method of heating. For small houses, steam pipes in the pits seem to be the most economical. In the plans accompanying this report are a number of different arrangements of conduits from the fans, most of them underground. The conduits may then be of brick and concrete and are permanent. When underground they are also entirely out of the way and do not obstruct the light. Various methods are employed to distribute the hot air to the pits, the chief point of interest being the methods of delivering the air under the engines and tenders for the purpose of quickly melting snow and ice. These require no comment, but it is evident that the plans are not of equal merit in this respect. The roundhouse pits of the Jersey Central at Elizabethport (Figs. 12 and 13) are fitted with elbows to direct the air to the machinery. These, when pushed into the bushings in the walls, automatically open the delivery dampers.

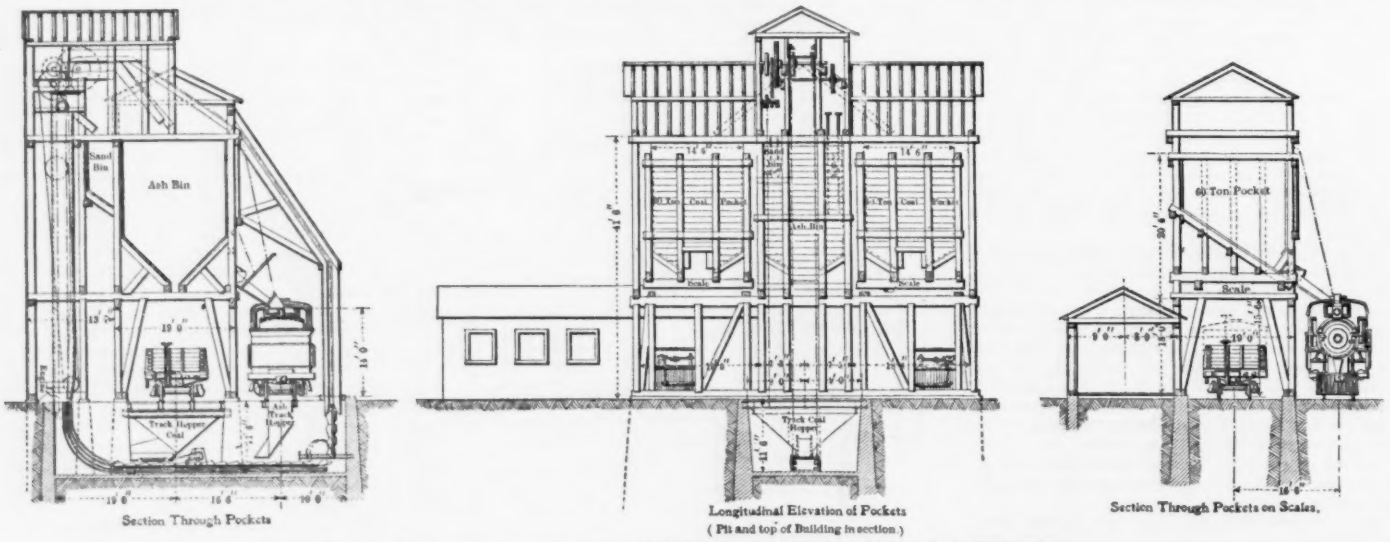


FIG. 22. ASH, COAL AND SAND HANDLING PLANT, CHICAGO & ALTON RY.

*Editor "The American Engineer," New York, N. Y.

For good ventilation the volume of air required from the fan is much greater than is required to pass through the fan for heating alone. A good rule is to require the air to be renewed every eight or ten minutes. Practice in heating and ventilating is not by any means uniform, and an attempt has been made to secure information which shall be a guide to good practice.

The variable factors are: Volume of house per stall, outside temperature range, character of exposure, use of live or exhaust steam, location of fanhouse, space available for fan and amount of heated air to be returned to the fan. In a roundhouse the air should not be returned to the fan. The form of the roof affects the heating. An average of about 33,000 cu. ft. of space per stall seems to represent usual construction. About 2,000 cu. ft. of air delivered per minute per stall gives good results. The committee found one case in which 800 cu. ft. per minute seemed to be ample. A range of from 125 to 150° F. seems to be satisfactory for delivery temperature. To estimate approximately the amount of steam in pounds per minute required for the heater, multiply the total volume of air supplied per minute by the number of degrees to which it is heated, divided by the constant 55.

In order to secure definite figures, one of the leading firms of engineers, making a specialty of heating and ventilation, was asked to submit suggestions based upon the roundhouse shown in Fig. 5 of this report, the conditions being those of the climate of Chicago, the minimum outside temperature being 20° below zero, the inside temperature to be 70° F., and the range of temperature of the hot air to be from 125 to 150° F. This information is as follows:

Number of stalls	42
Approximate cubical contents per stall	34,700 cu. ft.
Air supply per stall per minute	2,000 "
Total air supply	84,000 "
Temperature air supply	140° F.
Size of fan	11 ft.
Speed of fan	150 revs per min.
Size of engine	11 × 14
Lineal feet in heater	8,500 to 9,500

These figures are subject to some change, depending, first, upon the character of the exposure, the probable minimum outside temperature, variable steam pressure, and the amount of hot air returned to the fan. You can readily see that unless we were given a specific case and knew all of the conditions pertaining thereto, it is quite impossible to figure closely. We enclose herewith a sketch (Fig. 20) in which is shown in dotted line a suggested system of underground conduit for this roundhouse. We have shown also the approximate size of this conduit. If the fact that it is arranged to run under the radial tracks is a disadvantage, it could, of course, be placed near the outer wall. The proportions of this sketch are probably wrong, because the blue print enclosed is not scaled. The dimensions thereon are evidently not intended to be perfectly accurate.

Assuming the cubical contents per stall about 34,000 cu. ft., and assuming the temperature of delivery 125° F., a careful computation, taking into account only the heat loss from the walls, roof and windows, and making no allowance for the opening of doors and other accidental ventilation, we find that it will be necessary to supply 1,200 cu. ft. of air per minute per stall to maintain an inside temperature of 70° F., with an outside temperature —20° F. In order, therefore, to safely provide for accidental ventilation, the air supply should not be less than 2,000 cu. ft. This will serve to show that an air supply of 800 cu. ft. would hardly be large enough unless there were unusually favorable conditions to be met.

To secure the best conditions of ventilation and heating, it seems wise to consult the leading firms dealing in this apparatus and provide a liberal appropriation for the equipment, and to secure a fan capacity far greater than sufficient to maintain a comfortable temperature at all times, then to drive this fan hard enough to secure good ventilation through the smokejacks and roof ventilators.

SMOKEJACKS.—Nothing new in smokejacks has come before the committee. Wooden jacks, fireproofed with paint and sand, appear to be growing in popularity. They do not corrode. Telescopic jacks continue in favor where they are used, also those of tile and those having swinging lower sections to accommodate slight displacements of the engines.

BLOW-OFF AND WASHOUT PIPING.—There seems to be a marked tendency toward putting all water and steam piping about roundhouses in conduits underground. When exposed to gases the piping is apt to become leaky and this soon leads to great discomfort from the dripping of water and blowing of steam. Air and steam blow-off pipes are run overhead without serious inconvenience.

Blowing down the steam and water from boilers usually requires a long time, and better facilities should be provided. If steam is blown down from the steam domes a large pipe and large connections should be provided or the process will be too slow. Ideal practice would blow this steam off into a cistern to heat water for washing out. This is done at Collinwood, as illustrated in Fig. 21. The water from the blow-off cocks is often run off into the roundhouse pits and allowed to pass into the drain. At West Milwaukee, on the C. M. & St. P., the ash pits and roundhouse pits are piped for flexible joint connections to the blow-off cocks and the water disposed of to the drains, without filling the air with steam. This is an excellent plan, but there seems to be no objection to piping this water to the cistern for use again in washing out boilers.

The P. & L. E. roundhouse at McKee's Rocks, has ten pits set apart for boiler washing. These are piped to the sewer to avoid the escape of steam. There seems to be need of improvement in methods of washing out boilers. It should not require four hours to do this work, and yet this is quick time under average conditions.

LIGHTING.—For lighting the interior of a large roundhouse one large arc lamp at each pit, about 15 ft. from the floor and about 25 ft. back from the front end of the engine seems to answer very well. Incandescent lamps, three between each two pits, with additional portable lamps for attachment to plugs at the post, seem to serve equally well.

FLOORS.—A good floor, adopted by the New York Central for roundhouses, is prepared as follows:

Upon a leveled sub-grade an 8-in. bed of cinders is placed and thoroughly rammed. Upon this is placed a 5-in. layer of concrete, consisting of 1 part of Portland cement, 4 parts sand, and 7½ parts of broken stone. Upon this is a top dressing, 1 in. thick, composed of 1 part Portland cement and 1 part of sand. This is deposited simultaneously with the concrete to insure a perfect bond. The top is surfaced true with long, straight edges, and is floated to be smooth. Drainage is secured by raising the floor to a height of 2 ins. above the rails, midway between the pits.

This floor has been used for seven years by the New York Central with satisfactory results. It has no lodging places for water, dirt or grease, and is easily kept clean. It is also easily repaired. A good floor is also made by setting vitrified brick on edge in tar. Care should always be taken to secure perfect drainage and maintain a dry floor.

COAL, SAND AND ASH-HANDLING FACILITIES.—In a recent installation on the Santa Fe at Lorenzo, Ill., cars are hauled up an incline by a wire rope by means of a hoisting drum, which is driven by a 30-HP. Otto gasoline engine. One man operates the machinery, which has a capacity of 150,000 lbs. gross weight on a 20% incline at 20 ft. per minute. From the car the coal is delivered to the tender by gravity. At the top of the incline the grade is 1%, sufficient to start the cars at any time. Cables 600 ft. long are used in these plants. This is enough to permit of switching eight or ten cars with the hoisting apparatus, a switch being provided at the bottom of the incline for this purpose. A band-brake on the friction drum used in lowering the cars and the friction clutch is to hold a car at any desired point on the incline. The hand-wheel controls the band-brake, and it is easily operated. This brake seems to be a vital feature in the success of this hoisting arrangement.

Another plan, which has been extensively introduced on the Chicago & Alton, is illustrated by Fig 22. While various arrangements are employed, these engravings illustrate the principles which seem to be most important. This construction combines, coal, ash and sand handling facilities in one plant. Coal storage for 300 tons or more is also included. The chief interest in this plan centers in the large pockets (60 or 100 tons) which are capable of taking the entire load of the largest coal car, and in the fact that these pockets are suspended on scales, from which the amount of coal delivered may be actually weighed and autographic records of the delivery made for the attendant and the engineer. The plant covers two tracks, one for the receipt of coal from cars, and the other for locomotives to stand while they take coal and sand, and have their ash-pans cleaned. Coal from the cars is received in an underground hopper, and may be taken by the conveyor to the delivery pockets or to the storage. It may be taken by the same conveyor from the storage into the delivery pockets without shoveling. A hopper under the ash-pan of the engine receives the ashes and by the same conveyor are deposited in an elevated bin, to be chuted from time to time into a car for removal. Sand is stored in an annex, and after drying it is raised by an elevator into an elevated bin and chuted to the sand boxes of the locomotives. This design was developed and is manufactured by the Link Belt Machinery Co., of Chicago.

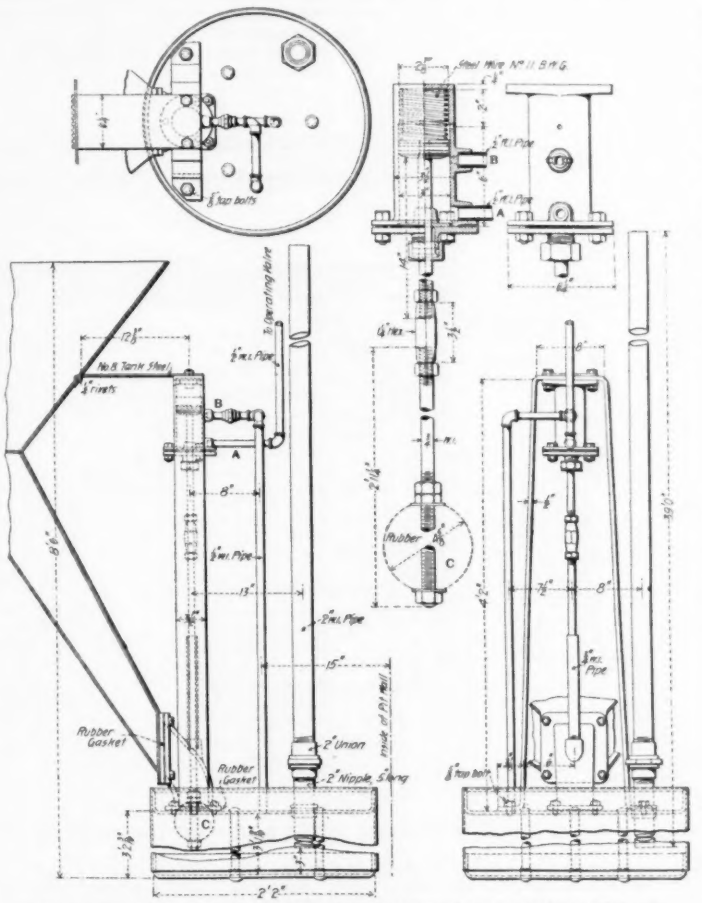


FIG. 23. SAND ELEVATING APPLIANCE AT COLLINGWOOD, O. ROUNDHOUSE.

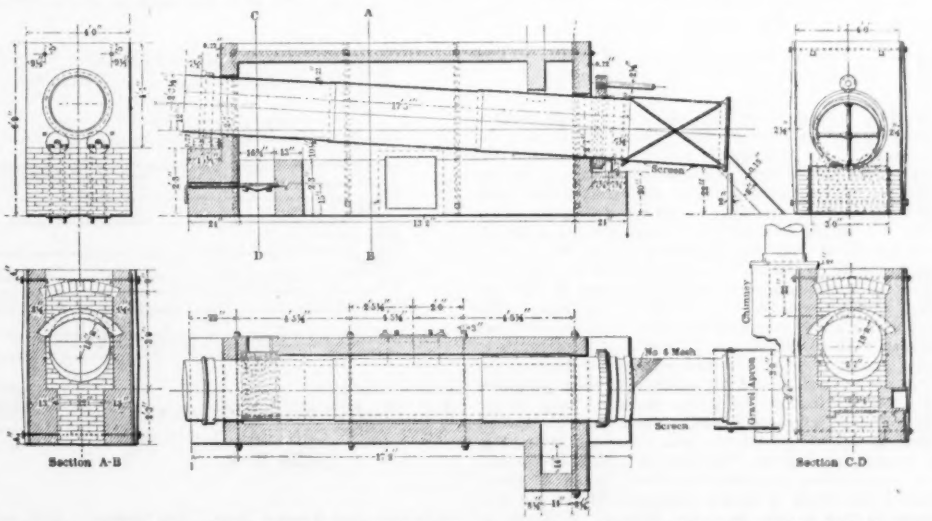


FIG. 24. ROTARY SAND DRIER AT WEST MILWAUKEE SHOPS, CHICAGO, MILWAUKEE & ST. PAUL R. R.

Among the details of this construction is an undercutting valve in the delivery chute, which can not become clogged by lumps of coal. It is intended that the entire plant shall be handled by one man. Similar facilities have been supplied to other roads. It is claimed that this apparatus handles coal at a cost of 2 cts. per ton. Attempts to weigh coal pockets have been made before, but this is believed to be the first successful application of scales to large pockets, with an arrangement which does not require shoveling. This is an exceedingly comprehensive combination. It is, however, dependent upon the machinery, a failure of which would "tie up" the ash as well as the coal handling facilities. For power 15-HP. Otto gasoline engines are used in these plants on the Chicago & Alton. In connection with these plants the water cranes have been located so that water may be taken at the coal pockets, and thus all of the outside work is done at one time and at one place. For larger roundhouses the same facilities may be duplicated to provide for several engines at a time.

SANDING PLANTS.—Where the demand for sand is large, as on roads with a concentration of a large nummer of engines in a small territory, it seems advisable to install central sand drying outfits and distribute the dry sand in box cars.

At Middletown, N. Y., the New York, Ontario & Western has a sandhouse of brick 25 × 46 ft. in size. Sand is received in gondola cars and shoveled through one of the windows. From the dryer it falls into a hopper and passes into a sand reservoir, from which it is elevated by compressed air into the dry storage for delivery to the engine on the tracks outside of the building. Other tracks may be reached from the storage bin if desired.

At Collinwood, on the Lake Shore (Fig. 3), sand is received over the coal-chute trestle, at the end of which it is dropped from the car into a storage bin. It is shoveled into a steam dryer and falls into either of two sunken

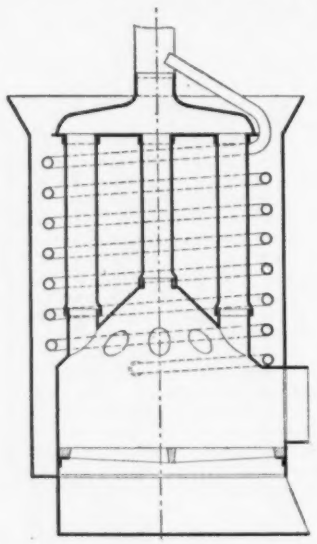


Fig. 25. Sand Drier With Perforated Pipe to Take Away Moisture, Chicago & Alton Ry.

reservoirs. From these it is elevated through straight vertical pipes into the dry storage above, and is ready for the engines. On applying air pressure to the sunken reservoirs, Fig. 23, the air first passes through a vertical cylinder. It raises the piston of the cylinder and closes the entrance from the dryer by means of a large rubber ball "C." When this ball-valve is closed the piston is high enough to uncover the opening to pipe "B," which admits the air to the reservoir and elevates the sand.

Fig. 24 illustrates a rotary sand dryer used on the Chicago, Milwaukee & St. Paul at West Milwaukee. The sand used there is very wet, and with it the machine has a capacity of 10 cu. yds. in 12 hours. This dryer is of boiler plate; it is inclined and screens the sand at the lower end. It is rotated by power, and when automatic conveyors are installed to deliver the green sand its capacity will be increased somewhat, and the labor cost of operating will be reduced one-half. The engraving, Fig. 24, shows a single grate. The dryer in use has two grates.

An improvement introduced on the Chicago & Alton, whereby the drying of sand is facilitated by the use of a perforated pipe to take away the moisture, is shown in Fig. 25.

ASH-PITS AND HOISTS.—Ash hoists are used in many forms for raising ashes from the ash-pits. Compressed air is generally used to raise buckets from the pits, one form of construction being shown in Fig. 26. The ash-pit is supplied with a number of clam-shell buckets, resting in cradles, with wheels to run on the pit rails beneath the engines. The hoist dumps these buckets into a car on the adjacent tracks. One large road is preparing to install an electric traveling crane over its ash-pits, believing that this will be the most satisfactory device which can be used for this purpose.

The depressed track ash-pit has not been altogether superseded by power devices, and is believed by many to be cheaper and more satisfactory than more elaborate equipment. Local conditions, however, do not always permit its use. When these tracks are used the pits should be of ample length, and the depressed track should be low enough to bring the top of the cinder car to the level of the ash-pit rail, and the side of the car should be very close to the rail. It requires rather careful study of conditions to determine the point where the advantage of power ash-hoisting devices begins. This depends upon

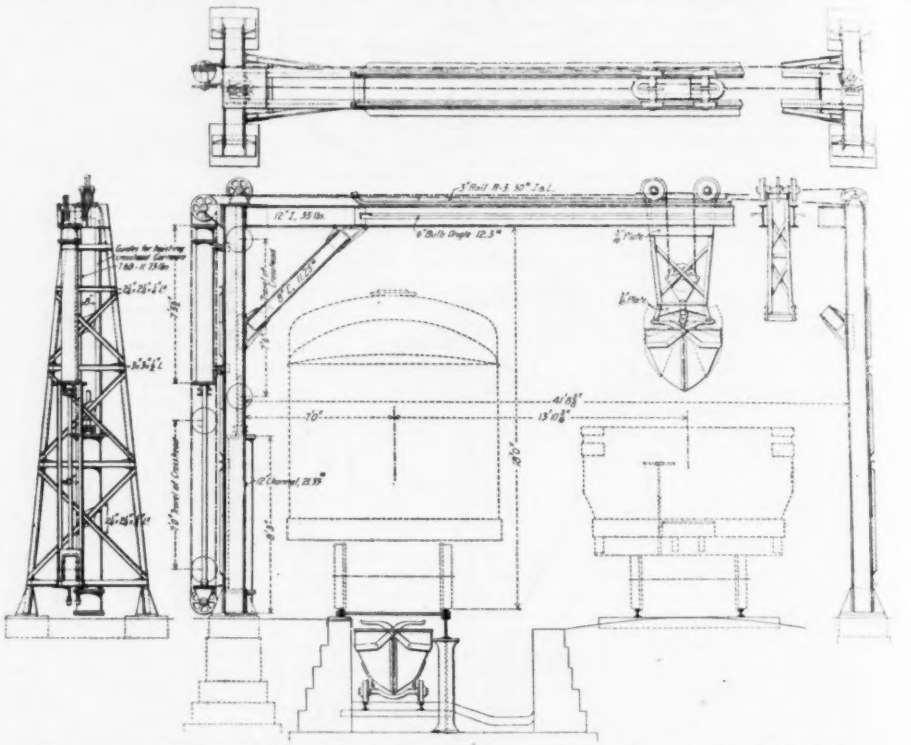


FIG. 26. COMPRESSED AIR HOIST FOR HANDLING ASH BUCKETS AT ASH PITS.

the number of engines and the available time of men who must be on hand for other purposes. Fig. 27 illustrates the standard double-track ash-pit of the New York Central.

WATER CRANES.—The most notable improvements in water service seem to be those on the Chicago & Alton. This crane is unusually flexible, and has a 15-ft. spout. When locomotives stop on the single track in either direction to take coal the tender must be opposite the center of the coal spout. This would bring the manhole of most tenders about 12 ft. to the right or left of the water spout. With the long water spout the manhole may be reached

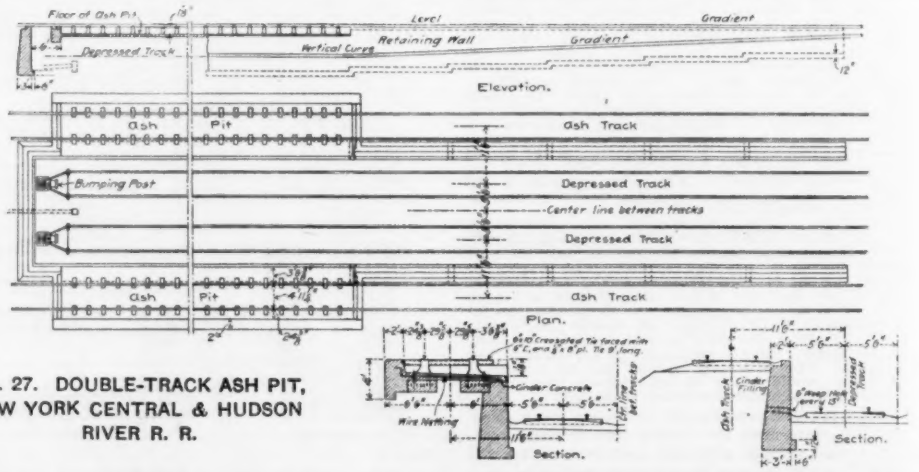


FIG. 27. DOUBLE-TRACK ASH PIT, NEW YORK CENTRAL & HUDSON RIVER R. R.

in either case without moving the engine. This long spout is used only for single-track sections, requiring the engine to make an exact stop at the same place in either direction for coal. This water crane delivers water at the rate of from 4,000 to 6,000 gallons in 1 minute, depending upon the length, directness and diameter of the pipe. While this seems, perhaps, unnecessarily large capacity for roundhouse service, it seems desirable to point out the importance of every time-saving facility at roundhouses as a money-saving investment. Standard water-crane apparatus is now being furnished which will supply 6,500 gallons per minute. The Chicago & Alton and Chicago & North-Western roads are leading in the installation of this equipment. Nearly all of the stand-pipes recently put in on these roads are 12 ins. in diameter.

ROUNDHOUSE SHOPS.—Irrespective of shop facilities for repairing locomotives, roundhouse equipment must now be kept up to a high degree of efficiency in order to reduce to the minimum the loss of time in doing the necessary work at terminals. In the present state of business the roundhouse must be near a shop, or it must have shop facilities in its own equipment.

The new Lake Shore roundhouse has a convenient shop, with the following tool equipment: A 26-in. triple [illegible] shaper, 36-in. × 36-in. - 12-ft. planer, 18-in. engine lathe with 5-ft. bed, 30-in. drill press, 24-in. engine lathe, a sensitive drill, a single Acme bolt-cutter, double-arbor emery-grinder, blacksmith's forge, pipe-bending blocks, and two screw presses. The Chicago & North-Western roundhouses have small special shops adjoining, and so also have the new roundhouses on the New York Central.

POWER-DRIVEN TURNTABLES.—Locomotives have become so heavy, and the demand for quick roundhouse service so urgent, as to necessitate power-driving for turntables, where many locomotives are handled. The choice of power depends upon circumstances. Electric motors are most satisfactory when power is available both night and day, and electric equipment is the simplest and most cheaply maintained. When an independent equipment is necessary, the gasoline engine offers peculiar advantages. It is the cheapest to install and is reported to be satisfactory. Compressed air and steam are also satisfactory and convenient. In cost of operation electric motors and gasoline engines are about the same, the expense for turning 250 engines every 24 hours being about $4, including repairs, gasoline or electric current. The cost of installation of a motor equipment is about $1,400. That of a gasoline engine is about $1,000, and that of a steam engine $1,200.

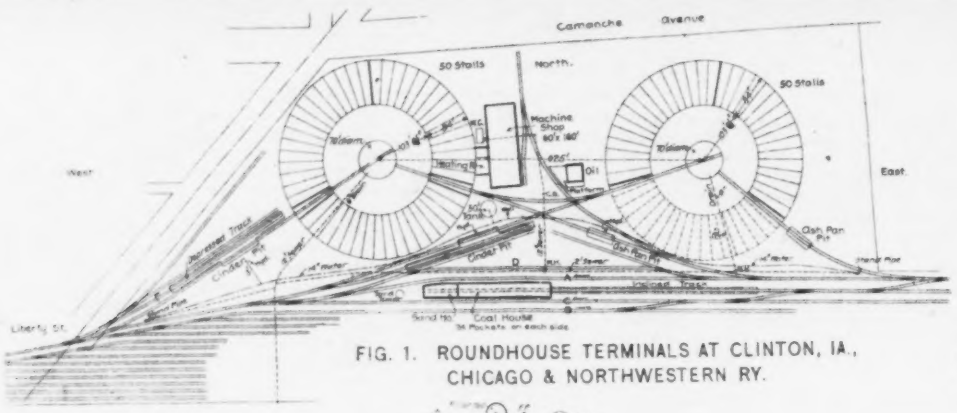


FIG. 1. ROUNDHOUSE TERMINALS AT CLINTON, IA., CHICAGO & NORTHWESTERN RY.

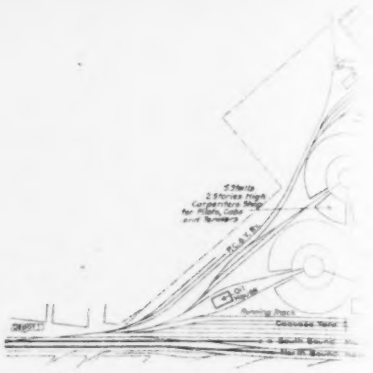


FIG. 2. ROUNDHOUSE TERMINA[illegible] McKEE'S ROCKS,

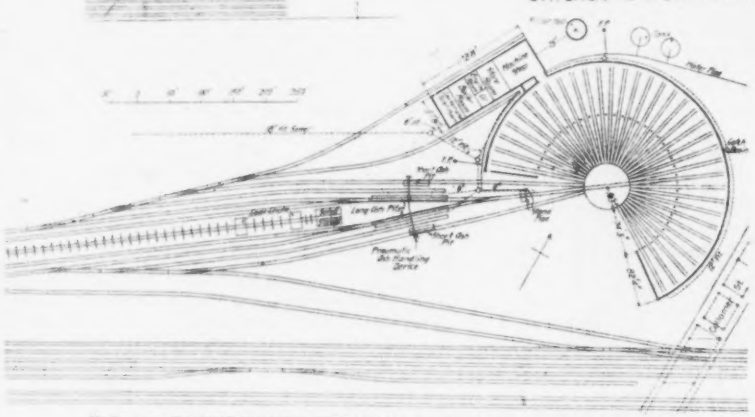


FIG. 3. ROUNDHOUSE TERMINALS AT COLLINGWOOD, O., LAKE SHORE & MICHIGAN SOUTHERN RY.

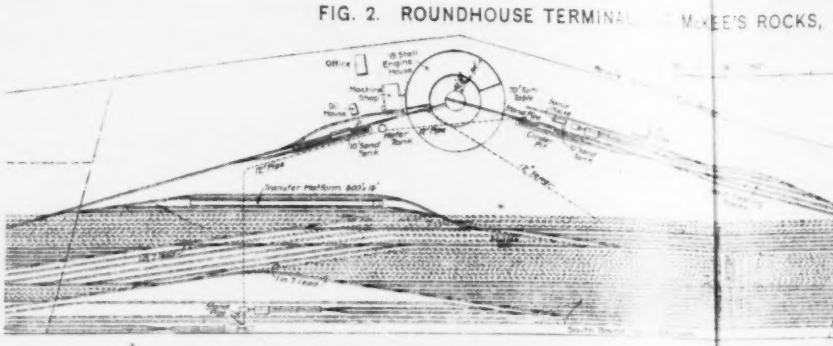


FIG. 4. ROUNDHOUSE TERMINALS AT FOND DU LAC, WIS., CHICAGO & NORTHWESTER

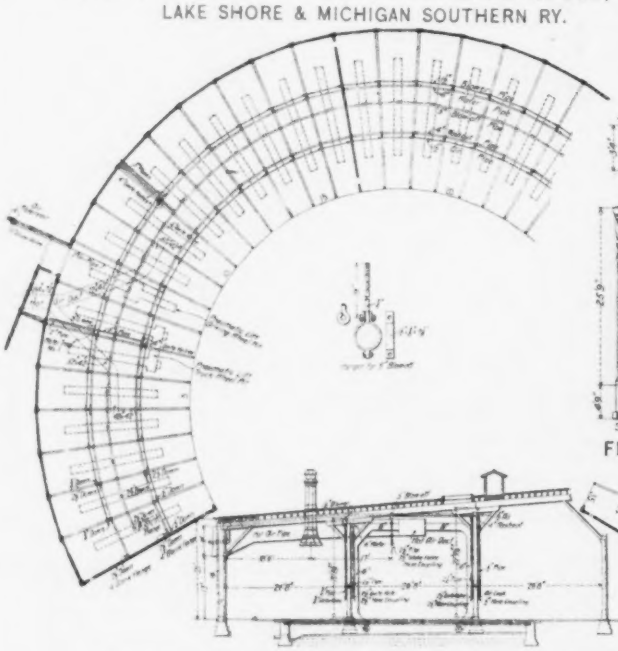


FIG. 6. GROUND PLAN AND SECTION OF ROUNDHOUSE AT COLLINGWOOD, O.

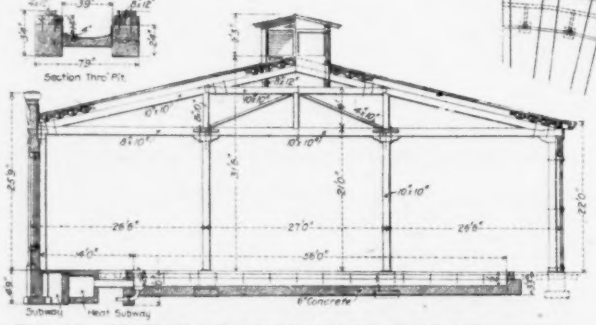


FIG. 15. SECTION OF ROUNDHOUSE AT DENVER, COLO., COLORADO & SOUTHERN R. R.

FIG. 13. GENERAL PLAN OF ROUNDHOUSE AT ELIZABETHPORT, N.

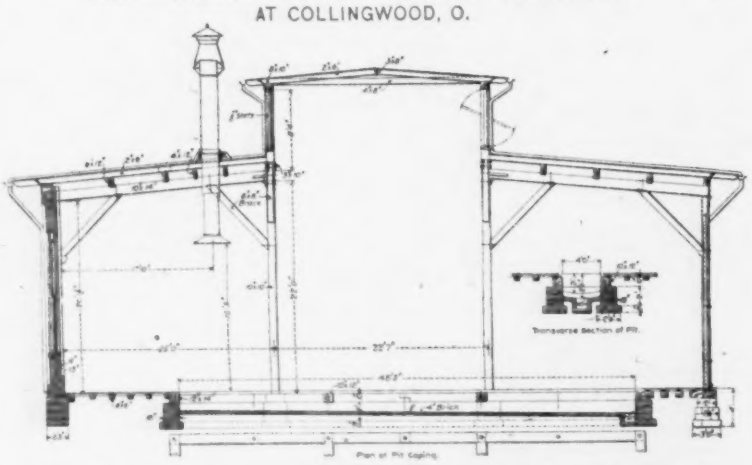


FIG. 16. SECTIONS OF ROUNDHOUSE AT NASHVILLE, TENN., LOUISVILLE & NASHVILLE R. R.

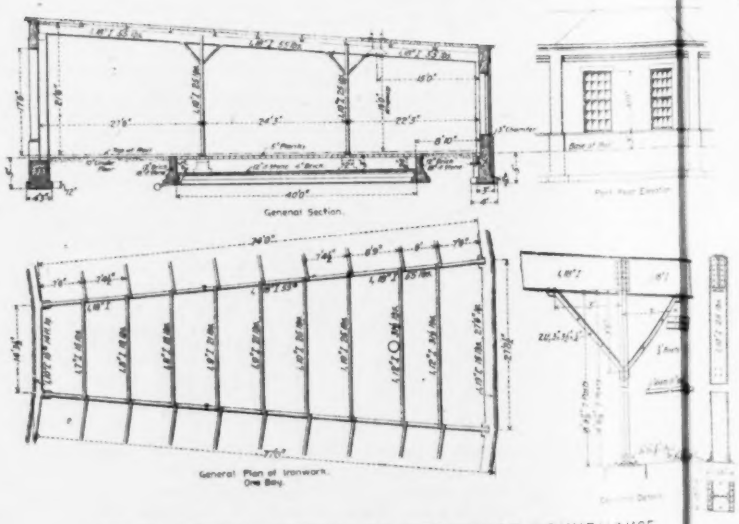


FIG. 7. GENERAL DETAILS OF FIRE-PROOF ROUNDHOUSE, CANADIAN PACIFIC RY.

SOME RECENT LOCOMOTIVE R

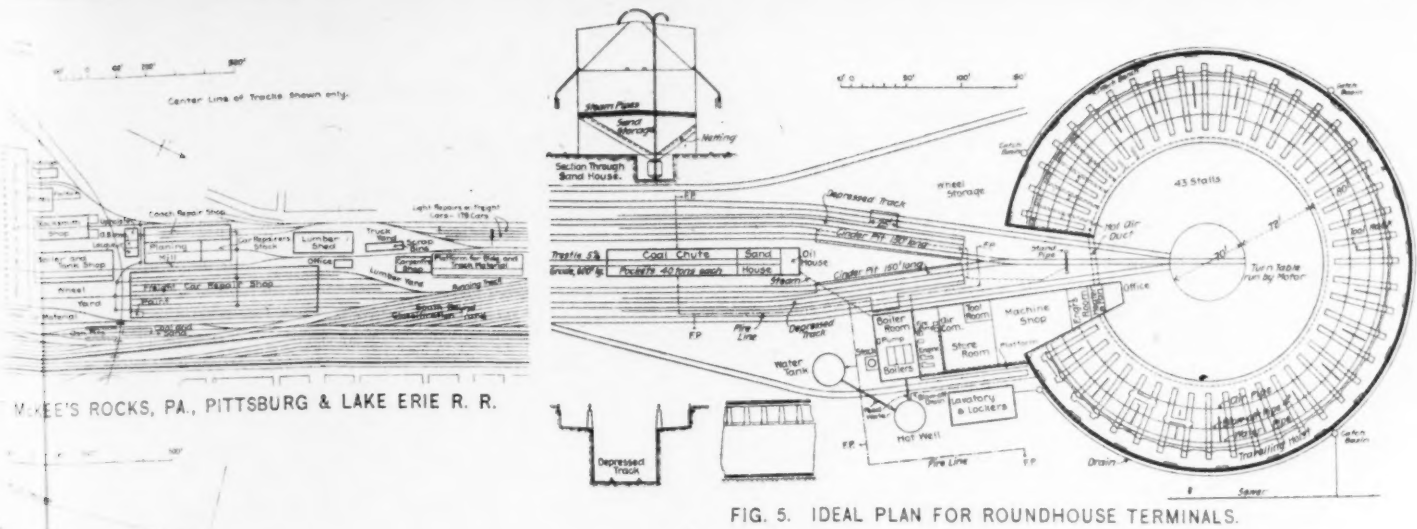
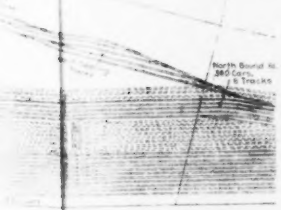
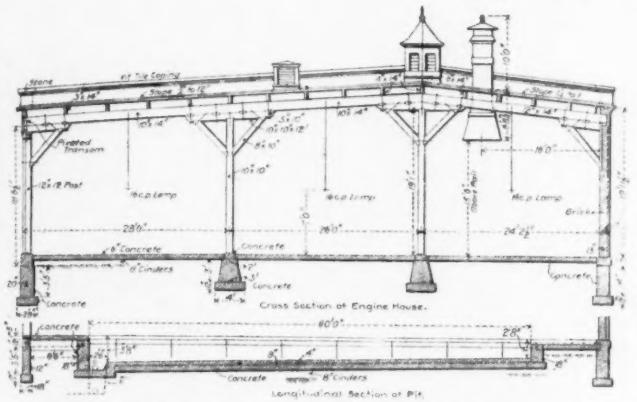


FIG. 5. IDEAL PLAN FOR ROUNDHOUSE TERMINALS.





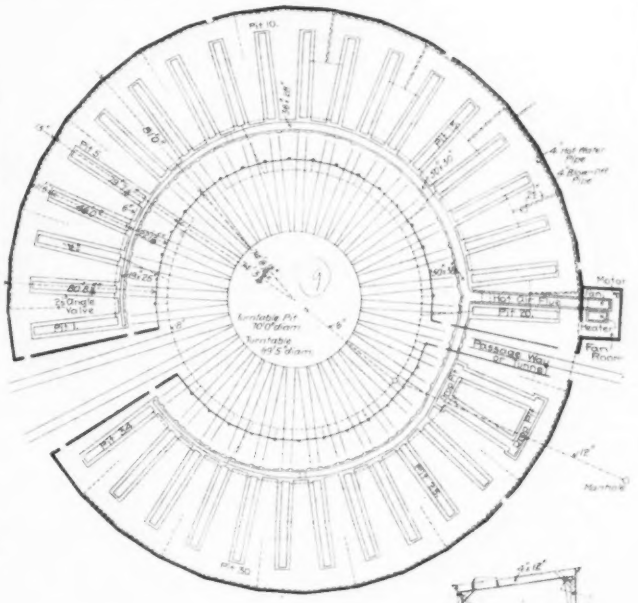
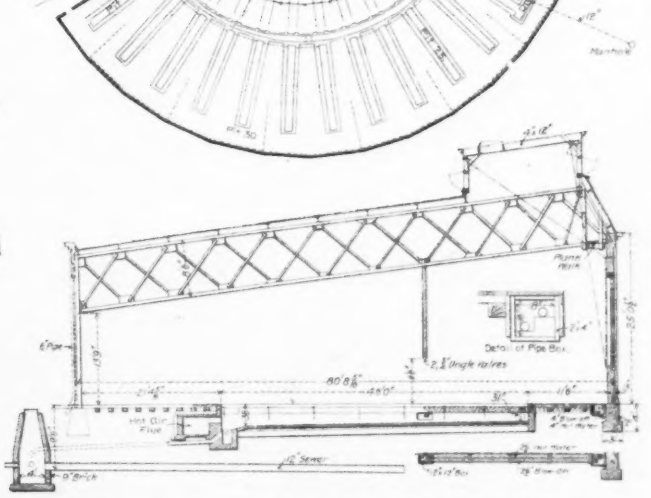


FIG. 8. SECTIONS OF ROUNDHOUSES RECENTLY BUILT FOR NEW YORK CENTRAL AND HUDSON RIVER R. R.



FIGS. 9 and 10. PLAN AND SECTION OF ROUNDHOUSE AT McKEE'S ROCKS, Pa.

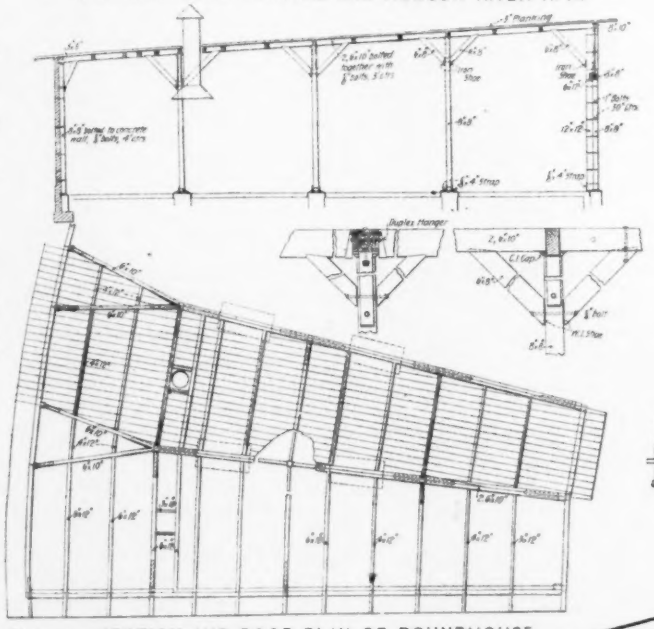


FIG. 12. SECTION AND ROOF PLAN OF ROUNDHOUSE AT ELIZABETHPORT, N. J., CENTRAL R. R. OF NEW JERSEY.

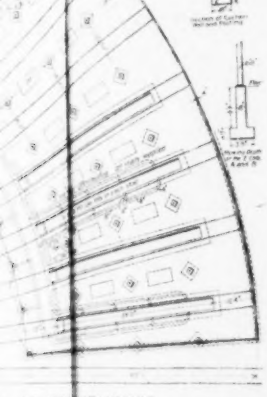


FIG. 11. SECTION OF ROUNDHOUSE AT MASON CITY, IA., CHICAGO & NORTHWESTERN RY.

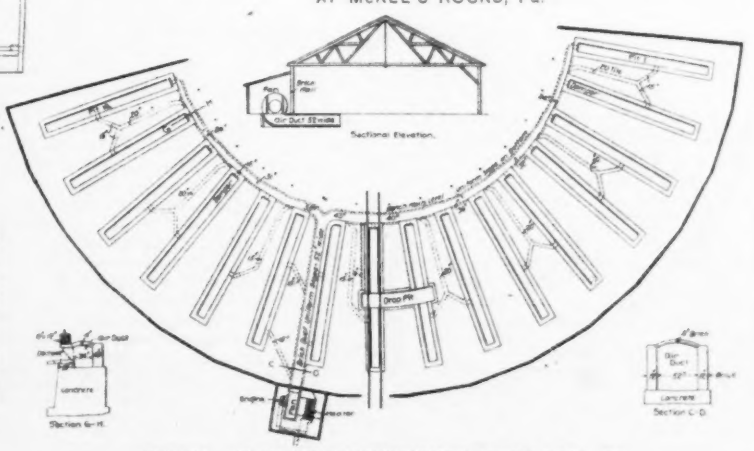


FIG. 14. PLAN OF ROUNDHOUSE AT DU BOIS, PA., BUFFALO, ROCHESTER & PITTSBURG R. R.

...LOCOMOTIVE ROUNDHOUSES.

CHAS. HART, LITH., 86 VESEY ST., N. Y.